CHAPTER 7

Preventing Occupational and Environmental Disease and Injury

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Prevention is the goal of occupational and environmental health and safety. It requires a systematic approach, effective communication, and constant feedback. Prevention generally involves a sequence of steps, including (a) gathering information about exposures and outcomes; (b) identifying problems; (c) developing, communicating, and implementing strategies for prevention; and (d) evaluating the outcome of these strategies.

All societal activities require vision, planning, and implementation—erecting buildings; establishing water, sewage, and transportation systems; developing sources of and distributing energy; growing, packaging, and distributing food; and planning entire cities. Occupational and environmental injuries and illnesses are, in one way or another, the result of these same activities. With enough care, resources, and commitment, we can prevent problems ranging from the adverse effects of air pollution and hazardous wastes to workplace illnesses and injuries. And we can continuously and sustainably shape our environment to reduce and eliminate health and safety hazards.

Whereas a coordinated, problem-solving approach is needed to reduce occupational and environmental hazards and prevent the illnesses and injuries they cause, most problems unfortunately occur where the system is either broken or does not exist, and most people affected encounter fragmented sources of assistance. The following situations demonstrate how health care providers, other health and safety professionals, and public health workers have missed opportunities for prevention and highlight common themes, such as the need for improved communication and enhanced feedback.

In the town of Libby, Montana, occupational health investigations conducted in the 1980s revealed asbestos-related diseases and deaths among workers who mined and processed asbestos-containing vermiculite ore. These workplace deaths were not seen as sentinel events. Vermiculite waste was not controlled until deaths from mesothelioma were reported in community residents in the 1990s.

Orders for leaded chemical products in an Indiana factory increased when a Pennsylvania competitor went out of business. As production increased, physicians monitoring workers for lead exposure found an increased number with high blood lead levels (BLLs). Physicians removed the workers with elevated BLLs from direct exposure to lead using the medical removal protection provision of the Occupational Safety and Health Administration (OSHA) lead standard, and returned them to work when their BLLs declined. Several workers went through this cycle repeatedly. Some of the occupational medicine records documented concerns workers had voiced about elevated BLLs among their children who had been routinely tested by their pediatricians. An OSHA inspection finally revealed that lead inadvertently brought home by workers caused the elevated BLLs in their children.

In the same factory, in response to an earlier OSHA inspection, an overhead exhaust hood was installed in the room where workers opened bags of inorganic

lead to feed into a hopper to be mixed into a final product. The purpose of the hood was to provide local exhaust ventilation to capture and remove lead dust from the workers' breathing zones. The workers had been using a table to hold the bags before opening them and dumping them; with the new hood, there was no room for the table, and bags were instead placed on and lifted from the floor. The number of back injuries resulting in lost work time increased.

A Maryland woman complaining of headache and vomiting was diagnosed with a viral syndrome and treated symptomatically. She and her family members returned the following night reporting the same symptoms and this time were diagnosed with carbon monoxide poisoning. Inspection of their home revealed a faulty furnace.

In these examples, opportunities for prevention are easily identified in retrospect. The manufacturer has the responsibility to identify hazards, both within the factory and in the waste stream, and control them and communicate the nature of the hazard to workers and to community members. Physicians conducting OSHA-mandated surveillance can communicate with factory managers and raise appropriate concerns. They should expect meaningful communication with safety officers until specific problems are identified and remediated. Frontline workers should be included in remediation discussions, and alternate strategies should be explored, such as use of bags that do not need to be opened because they dissolve in the mixing process. Finally, opportunities for enhanced communication among physicians, other health care providers, and public health practitioners abound. Joint approaches to primary prevention, ranging from information about smoke detectors and carbon monoxide monitors to awareness about lead exposure (Fig. 7-1), might also involve fire departments, schools, and community-based nongovernmental organizations.

The themes that emerge reinforce the need for effective communication, sharing of data, and systematic follow-up evaluation to confirm that improvement has been achieved. Information-sharing that empowers individuals to identify hazards and take appropriate steps for intervention produces critical improvements in activities. Examples include hazard prevention and control (a) by individuals, such as seatbelt use and smoking cessation; (b) by communities, such as construction of safe bicycle paths and speed bumps; and (c) by workplace safety and health teams. Successful programs have been shown to reduce patient assaults on nursing home workers, back injuries among hospital-based nursing assistants and orderlies, dermatitis among printing workers, needlesticks among health care workers, ambient lead levels following conversion to lead-free gasoline, and fatalities after introduction of air bags into cars.[1–3]

FIGURE 7-1 • Bee Lead Safe educational project for Head Start Program children and their parents. (Photograph by Earl Dotter.)

Systems approaches can guide comprehensive safety and health programs. In these approaches, it is often recognized that no injuries are acceptable. Comprehensive safety and health programs developed by federal OSHA for voluntary use have been required by several state-plan OSHA programs. These programs, which include a "plan–do–check–act" cycle, engage frontline workers in systems approaches. They rely on management commitment, employee participation, hazard identification and control, training, medical monitoring, and program evaluation. These programs have been successful to the extent they empower

workers to identify needs and participate to bring about change. However, many of these programs have failed to share resources or genuinely empower workers, engendering suspicion and limiting program implementation and effectiveness. Similar comprehensive approaches have been developed to reduce environmental hazards. The EPA's Pollution Prevention Initiative (Box 7-1) identifies alternatives that reduce the production of pollutants. The International Standards Organization (ISO 14000) management standard can help management to reduce environmental pollution from industry. To be effective, these programs require external verification and constant engagement of vigilant civic groups and nongovernmental organizations that empower community members.

It often takes the concerted effort of professionals in health care, general public health, and occupational and environmental safety and health working together with patients, employers, representatives of community organizations, and government officials to address complex problems. However, each member of this team has the ability to initiate improvements. We are each responsible for ensuring that change happens, while at the same time we are only able to bring about positive change if we communicate effectively and engage others.

The following three examples of major improvements show how communication, focus, and persistence at the individual level and in the public health policy arena can reduce exposure and improve lives—although in each of these examples, much work remains to be done.

Lead Exposure

Lead has been widely used in plumbing and manufacturing, and its toxic effects have been recognized for centuries. Yet it continues to cause adverse health effects in some workers, young children exposed to lead-based paint, and others. One of the most significant population-based exposures in the 20th century occurred when organic lead was added to gasoline as an antiknock agent that made combustion engines more efficient and contributed to the ascent of the automobile as the dominant mode of transportation. Thousands of tons of lead oxide were exhausted from tailpipes, contaminating ambient air and settling in dust and on crops. By the mid-1970s, the geometric mean BLL for the U.S. population as a whole approached 16 μg/dL, a level now known to cause adverse neurologic effects. Based on the research of scientists and the advocacy of environmental nongovernmental organizations and associations of health professionals, EPA regulated the removal of lead from gasoline. Over the nearly three decades since, BLLs in the U.S. population have declined, with the geometric mean BLL now below 2 μg/dL. Additional efforts to ban lead as a pigment in paint, in water-carrying pipes, and in solders used for canned foods have also had a positive impact, although problem areas persist, especially in areas with older houses. With the decline of BLLs among children aged 1 to 5, only about 2 percent of them have BLLs over 10 μg/dL—the CDC level of concern.[4]

Environmental Tobacco Smoke

Since the Surgeon General's seminal report in 1964 on the hazards of cigarette smoking, the tobacco industry has fought back, such as by attacking the science that demonstrated the adverse health effects of environmental tobacco smoke on nonsmokers. Smoking cessation programs, one-on-one counseling by primary care physicians, educational and advocacy projects by nonprofit organizations, legislation restricting smoking, and individual and state lawsuits have increased public awareness and reduced the percentage of smokers in the United States. As a result, among nonsmokers, levels of cotinine (a biomarker for environmental tobacco smoke), declined 58 percent during the 1990s for children, 55 percent for adolescents, and 78 percent for adults.[4]

Mining Fatalities

Mining remains the industry with the highest rate of fatal traumatic injury, although this rate declined 92 percent from 1911 to 1997. Public outcry in response to horrific disasters led to a series of federal responses, including the establishment of agencies to conduct research in and to regulate mining. The reduction of fire, explosion, collapse, asphyxiation, and other hazards has been the result of improvements in technology, training, and enforcement. Lessons learned from improvements in this industry may help improve safety in other high-hazard industries, such as construction and agriculture.

APPROACHES TO PREVENTION

Primary prevention identifies a hazard and either (a) prevents susceptible individuals from becoming

BOX 7-1

Avoiding the Transfer of Risk: Pollution Prevention and Occupational Health

Rafael Moure-Eraso

The growing national concern with environmental pollution became acute in the past decade because of the increase in waste-generating activities by industry. The U.S. Congress responded to this concern by enacting the Pollution Prevention Act of 1990. Congress reflected the consensus of the scientific community that waste management and control alone will not resolve environmental problems in the long run and that a change of approach—a *paradigm shift*—from pollution control to pollution prevention was necessary. Source reduction is the strategy of choice to achieve pollution prevention. Only to the degree that this cannot be achieved is it appropriate to turn to pollution control activities such as treatment, disposal, and remediation.

Pollution prevention has begun to take hold. It provides, for the first time, a coordinated effort of primary prevention, eliminating the possibility of pollution-related health effects and superseding *end-of-pipe* interventions. Thousands of companies in the United States have established pollution prevention programs.

These developments have critical implications for occupational health. The important conceptual change from control of environmental exposures to their prevention through source reduction and changes in process methods allows the workplace to be seen as a separate source of pollution when undertaking a comprehensive and systematic pollution source evaluation. When industries that use chemicals as raw materials begin to look at changing materials and processes as an environmental health strategy, the opportunity exists to incorporate workplace pollution exposures into the equation and prevent the choice of substitute materials without consideration for the impacts of any proposed changes on the exposures within the plant. Consequently, the working population and work environment can be given equal footing with the general population when pollution prevention strategies are planned.

The establishment of this understanding as the foundation for pollution prevention activities requires a change in both environmental health and occupational hygiene practice. Just as previous environmental health activities did not consider root causes and their prevention, traditional workplace-based exposure control activities have been end-of-pipe interventions designed to control exposure without systematically examining root causes. Consequently, it was not recognized that a preferred engineering control such as local exhaust ventilation tended to shift the burden from the workplace to the ambient environment in the form of air pollution or solid hazardous waste (via contaminated filters or other pollution collection media). Unless source reduction or process modifications are examined comprehensively, occupational hygienists may be equally responsible for shortsightedness. So, work environment scientists must join environmental health scientists in a unified effort to avoid simply shifting risk among different media (Table 7-1).

For this conceptual potential to be realized, the occupational health professional must be at the table during discussion of pollution prevention strategies. The six general pollution prevention (source reduction) strategies that most directly affect occupational health are raw material substitution or reduced use, closed-loop recycling, process or equipment modification, improvement of maintenance, reformulation of products, and improvement of housekeeping and training.

Some examples of pollution prevention interventions that incorporate concern for reduction or elimination of work exposures are the following:

1. In industrial textile dry-cleaning operations, water-based solvents have been successfully substituted for perchloroethylene. This change eliminates exposures to a potential human carcinogen, but also leads to reduced volatile organic compounds in ambient air, improved dry-cleaning job organization, and decreased ergonomic risk factors.
2. In the offset lithography industry, the solvent with the lowest concentration of aliphatic organic chemicals has been successfully substituted for regular organic solvents to clean printing ink from metal surfaces. Products with high organic chemical content were found to perform no better than those with lowest.

(continued)

BOX 7-1

***Avoiding the Transfer of Risk: Pollution Prevention and Occupational Health** (Continued)*

3. In painting of small metal parts, the introduction of an electrostatically delivered coating was successful in replacing a resin-based epoxide paint. Not only were the respiratory and skin hazards from epoxide exposures eliminated, but the paint dispenser was made substantially lighter, avoiding an ergonomic hazard.

Occupational hygiene should strive to change its most common practice from secondary to primary prevention by addressing workplace problems as an aspect of the comprehensive production system, which has impacts both inside and outside the point of production (see Table 7-1). Neither work environment problems nor worker and community concerns can be compartmentalized.

Bibliography

Ellenbecker MJ. Engineering controls as an intervention to reduce worker exposure. Am J Ind Med 1996;29:303–307.
Broadens the definition of substitution to include process changes and presents field examples of interventions. Also describes the general methods of pollution prevention (toxic use reduction).

Goldschmidt G. An analytical approach for reducing workplace health hazards through substitution. Am Ind Hyg Assoc J 1993;54:36–43.
Describes a systematic approach involving analysis of health characteristics of raw materials (162 examples from Denmark are summarized) for the purpose of choosing as alternatives more environmentally and occupationally benign materials.

Lempert R, Norling P, Pernin C, et al. Next generation environmental technologies: benefits and barriers. Santa Monica, CA: The RAND Corp., 2003.
This study of the benefits and barriers of next-generation environmental technologies in a number of U.S. industries concluded that, although in its infancy, green chemistry technologies provide significant benefits for occupational health, environmental health, and economic security.

Quinn MM, Kriebel D, Geiser K, et al. Sustainable production: A proposed strategy for the work environment. Am J Ind Med 1998;34: 297–304.
This paper calls for expansion of the role of the occupational health professional to include evaluation and redesign of production processes. It also calls for new research to develop these activities as the scientific and public health policy basis of sustainable production.

Roelofs CR, Moure-Eraso R, Ellenbecker MJ. Pollution prevention and the work environment: The Massachusetts experience. Appl Occup Environ Hyg J 2000;15:843–850.
This paper evaluates the impact on occupational health practices in 35 Massachusetts firms where the state promoted cleaner production alternatives. The study concluded that toxics use reduction activities improved the work environment, but that such improvements were neither systematically planned nor incorporated into their activities. Information about superior technologies regarding existing options to protect both workers and the environment were also missing.

exposed to it (usually through engineering interventions or substitution), or (b) strengthens the individual, such as through immunization. Secondary prevention identifies early evidence of a disease (usually by screening) at a stage where intervention (such as by medical treatment) can cure or prevent further progression of the disease. Tertiary prevention attempts to reduce the impact of illness or injury and associated disability, such as through medical care, rehabilitation, or environmental or workplace adjustments. All of these approaches require effective communication and information-sharing among a wide range of professionals, including some combination of physicians, nurses, physician assistants, occupational hygienists, epidemiologists, other health workers, engineers, planners, community members, workers, managers, and others.

Primary Prevention at the Public Health Level

The Centers for Disease Control and Prevention (CDC), in partnership with a wide variety of stakeholders, has developed a nationwide goal of transforming the current patchwork of environmental health programs and services into a system of public health resources that would enable each state to provide comprehensive, updated environmental services that would adequately address traditional problems, such as water purity and food sanitation.

Examples of primary, secondary, and tertiary prevention. (Drawing by Nick Thorkelson.)

as well as emerging environmental health threats. This approach is similar to an occupational health systems approach, but on a larger scale. The following is an outline of 10 essential environmental health services needed for prevention:

1. Monitoring health status to identify community environmental health problems;
2. Diagnosing and investigating environmental health problems and health hazards in the community;
3. Enforcing laws and regulations that protect health and ensure safety;
4. Linking people to needed environmental health services and assuring the provision of environmental health services when otherwise unavailable;
5. Assuring a competent environmental health workforce;
6. Evaluating the effectiveness, accessibility, and quality of personal and population-based environmental health services;
7. Developing policies and plans that support individual and community environmental health efforts;
8. Mobilizing community partnerships to identify and solve environmental health problems;
9. Informing, educating, and empowering people about environmental health issues; and
10. Conducting research for new insights and innovative solutions to environmental health problems and issues.[5]

In most situations, a public health approach to prevention aims to "move upstream" to address the primary sources of a health problem (Fig. 7-2).

Primary Prevention at an Organizational Level

Substitution of a Less Hazardous Process for a More Hazardous One

Examples of process substitution may be on a large or small scale. Train, bus, and subway travel cause fewer deaths and disabling injuries due to crashes and emit fewer pollutants than automobile travel. Transdermal patches and oral medications, where effective, reduce the need for sharps exposures in health care. The use of wind or solar energy reduces pollution from fossil-fuel utilities and reduces reliance on nuclear-power plants, with attendant concerns about reactor safety and nuclear

TABLE 7-1

Pollution Prevention and Occupational Health: Occupational Hygiene as an Instrument for Primary Prevention

Occupational Hygiene Approaches	Primary Prevention	Secondary Prevention
Anticipation	*Hazard surveillance*	—
Identification	*Hazard identification*	*Medical surveillance*
Evaluation	*Exposure assessment*	—
Controls	*Exposure prevention*	*Control of generated exposures*
	Comprehensive	End-of-pipe
	Source reduction	Engineering controls
	Materials changes	Enclosure
	Substitution	Local exhaust
	Process changes	Wet methods
	Physical conditions	General ventilation
	Machinery	Administrative controls
	Operations	Personal protective equipment
	Work organization	*Early therapeutic intervention*

waste transportation and disposal. In all of these examples, residual risks remain, which require continued tracking of adverse health effects and development of additional process improvement, which relies on engineering and also requires planning, training, communication, and evaluation to be effective.

Substitution of a Less Hazardous Substance for a More Hazardous One

An example of this type of action is the substitution of synthetic vitreous fibers, such as fibrous glass, for asbestos. Substitution carries certain risks, because substitute materials often have not been adequately tested for health effects and may, in fact,

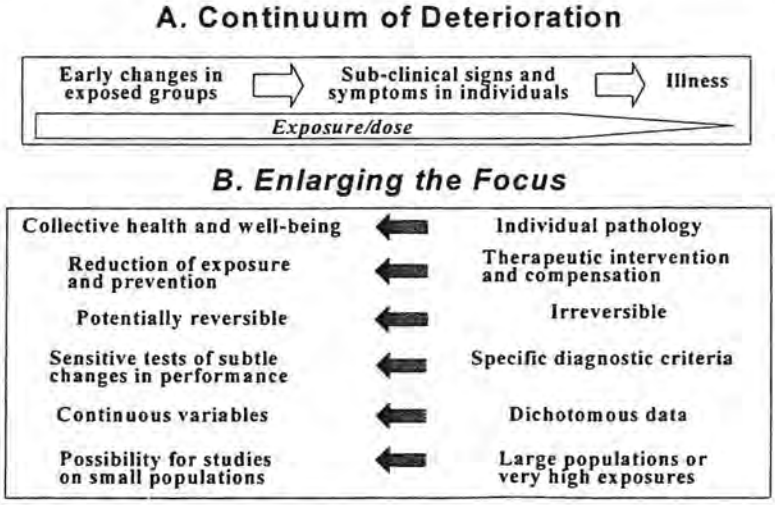


FIGURE 7-2 • Moving upstream: Understanding the relationships of exposure to clinical illness offers the opportunity, in many different ways, to seek the earliest possible evidence of effects in order to prevent the chain of events and identify reversible changes. (Courtesy of Donna Mergler.)

be hazardous. For example, years ago fire protection was enhanced by replacing flammable cleaning solvents with carbon tetrachloride. Increased use of carbon tetrachloride led to identification of its hepatotoxicity and its subsequent replacement by less toxic chlorinated hydrocarbons. Now there is concern that use of chlorinated hydrocarbons should be reduced to better protect the general environment. The lesson in this evolution is not that substitution is hopeless, but that the introduction of a substituted material should be considered only a first step and that the impact of the substitution must always be monitored to determine whether initially unrecognized problems develop after increased use of the new material. The substitution approach is embodied in the broader concept of pollution prevention, described in Box 7-1.

Installation of Engineering Controls and Devices

These approaches are more often available than substitution and cover a wide range of effective options to reduce hazards, such as:

- Installing airbags in automobiles;
- Installing ventilation exhaust systems that remove hazardous dusts (Fig. 7-3);
- Using jigs or fixtures to reduce static muscle contractions while holding parts or tools;
- Applying appropriately designed sound-proofing materials to reduce loud noises that cannot be engineered out of a work process. (Sound barrier walls along highways help shield neighborhoods from noise using this same principle.)
- Installing tools on overhead balancers to eliminate torque and vibration transmitted to the hand;
- Constructing enclosures to isolate hazardous processes;
- Installing hoists to eliminate manual lifting of containers or parts;
- Carefully maintaining process equipment to reduce or eliminate (a) fugitive emissions from processes designed as closed systems, or (b) the development of unwanted vibrations as equipment ages;
- Using scrubbers or other mechanisms to reduce airborne pollutant emissions;
- Maximizing fuel use through cogeneration of hot water from the heat exhaust produced as a by-product of generating electricity; and
- Treating waste-water effluent before discharge.

FIGURE 7-3 • Local exhaust ventilation used to protect a worker from asbestos dust generated in working with clutch plates. (Photograph by Earl Dotter.)

Although installation of these engineering controls can involve a substantial initial capital expenditure, they often save money by reducing materials use, reducing toxic and other material wastes, and reducing costs of disease, injury, and absenteeism. Often, such approaches are not considered or implemented because of lack of awareness that such solutions are available and cost-effective.

Job Redesign, Work Organization Changes, and Work Practice Alternatives

A number of changes can be introduced that take advantage of methods that directly reduce or eliminate various types of risks in work processes. These include job redesign, changes in work organization, and alternative work practices. Job redesign, which often combines engineering and administrative aspects, typically seeks several related objectives: to increase job content, to make the physical work less redundant or repetitive, and to improve workers'

opportunity to exercise individual or collective autonomy in decision making (see Chapter 16).

Changes in work organization, often closely integrated with individual job redesign, are directed at elimination of undesirable features in the structure of work processes. For example, a change from piece-rate work (with incentive wages) to hourly-rate work removes inappropriate pressure and tension—both physical and mental—on affected workers. Piece-rate work has been associated with higher rates of musculoskeletal problems in a variety of work settings. Another example is the elimination of machine pacing, which tends to enforce repetitive and mind-numbing work.

Work practice alternatives can, through relatively limited changes, lead to important improvements in the work environment. For example, dust exposures in a variety of settings can be significantly reduced by the introduction of vacuum cleaning in place of compressed air to clean dusty surfaces and wet mopping in place of dry sweeping wherever possible.

As a rule, these preventive measures are more effective than methods that primarily affect the worker. The measures that follow potentially reduce the damage that may result from workplace hazards without actually removing the source of the problem.

Primary Prevention at an Individual Level

The following sections address opportunities for primary prevention. Primary prevention in the workplace offers the opportunity for health promotion (Box 7-2).

Education

Education concerning specific environmental and occupational hazards is an essential aspect of safety and health. This is an aspect of information-sharing that is important on a number of levels: basic information about adverse effects of specific exposures conveyed in a manner that the individual is able to use is a form of empowerment. Health educators have developed and evaluated a variety of different theories in order to describe the various steps individuals use to understand a specific hazard, to assess their potential to impact that hazard, and then to decide to act. Much scientific evidence supports specific approaches to encouraging healthy behaviors, such as using seat belts and bicycle helmets, checking home smoke detectors, and quitting smoking. Different approaches are needed for different activities.

The Environmental Protection Agency (EPA) has developed rules for effective risk communication for environmental hazards that clearly distinguish, for example, risks over which the individual has perceived control, such as automobile crashes—regardless of the extent to which individual control is actually the determining factor. Information that reintroduces some aspect of control—even if it is just information about where to obtain additional information or how to register and follow up on a complaint—is an important aspect of education and training. Workers should always be given full information about workplace hazards and means of reducing their risk (Fig. 7-4). Many safety measures necessitate changed behavior by workers, which also requires education or training. Workers who are not aware of job hazards will not take the health and safety precautions necessary to protect themselves and their co-workers. (See Box 7-3, Fig. 7-5, and information on the OSHA Hazard Communication Standard in Chapter 3.) Although training itself will not replace needed equipment, the equipment may be rendered useless or worse in the absence of effective training. Effective training that builds on life experiences and empowers the individual to address and solve problems is a cornerstone for all health and safety prevention.

Personal Protective Equipment

Use of personal protective equipment (PPE), such as respirators, earplugs, gloves, and protective clothing (Fig. 7-6), or safety devices, such as helmets, seat belts, and child restraint systems, will continue to be necessary in some workplace settings, where it is the only available protective measure, and for most transportation safety. However, this approach to controlling a hazard often has important limitations; for example, workers often resist wearing such protection because it is cumbersome or causes other difficulties. The effectiveness of PPE should be evaluated in actual use where the experimentally determined effectiveness claimed by its manufacturer may not apply. OSHA has developed lists of acceptable PPE that can be helpful in proper selection and use of this equipment. OSHA and other authorities have also emphasized the need for and importance of developing a complete program for PPE, not only a requirement for its use. Adequate programs include requirements

BOX 7-2

Health Promotion in the Workplace

Gregory R. Wagner

The protection, preservation, and improvement of the health of people who work are goals shared by workers, their families, and their employers. Ill health and injury, whether caused by work or nonwork activities, reduces income, quality of life, and opportunity, not only for the directly affected individuals but also for those dependent on them. Nevertheless, in the public health and employment communities, there has been a long-standing separation between those interested in control of health risks and hazards from work and those focused on individual and community health risk reduction outside the workplace.

Some occupational health specialists have been concerned that worksite health promotion and disease prevention programs may draw needed resources from occupational health protection programs and, at worst, may amount to victim-blaming, distracting attention from the occupational health needs of workers. There is concern that a narrow focus on health promotion could deflect employers from their legal responsibilities to provide workplaces free of recognizable hazards. Health promotion/disease prevention specialists often see the workplace as a convenient and valuable venue to provide important health improvement services to a priority population, without attention to work-related risk. These distinct perspectives are reflected in the separate training of occupational health practitioners and researchers and those focused on health promotion and health education.

The systems of payment in the United States for the medical costs of disease and injury have also contributed to this dichotomy. Conditions caused or significantly exacerbated by workplace conditions and exposures are supposed to be covered through workers' compensation insurance programs that are separate from any health insurance benefits paying for care for—or, in rare instances, prevention of—diseases and injuries "of everyday life." Any cost savings that result from improved health of workers may not be sufficiently clear or timely to be attributed to successful programs.

There is a limited, but growing, body of evidence and opinion that the separation of focus on at-work and off-the-job risks is artificial and is not optimally serving either workers or their employers. Certain health-risk behaviors, such as smoking, are nonrandomly distributed through the working population: blue-collar workers are more likely to smoke—and are less likely to quit successfully—than white-collar workers. Exposure to specific workplace conditions may increase risk for chronic diseases, such as chronic obstructive pulmonary disease (COPD), depression, and cardiovascular disease—otherwise characterized as "diseases of everyday life." Workers may inadvertently transport toxins home, putting themselves and family members at risk. Concurrent interventions at work to reduce adverse workplace hazards and to promote reduction of tobacco use in blue-collar manufacturing workers have been more successful than those focused solely on tobacco cessation.

A number of employers, with the support of the workers they employ, have implemented integrated programs to protect, preserve, and, at times, improve the health of the workers by focusing broadly on the diversity of factors—work-related and personal—that contribute to health and disease. Successful programs appear to have the following elements in common:

- Active communication among all interested parties;
- A true commitment to identification and intervention in problems of concern to the workforce;
- A commitment to health-supportive work policies (on sickness leave, tobacco use, health insurance, employee assistance programs, and other issues);
- Reasonable incentives for worker participation;
- Attention to identification and control of workplace stressors;
- A high level of coordination or integration among all program elements;
- Well-designed interventions; and
- Ongoing evaluation and program adjustment based on both process data and health and risk factor outcomes.

(continued)

BOX 7-2

Health Promotion in the Workplace (Continued)

There are a number of barriers to the adoption of integrated programs for health protection and promotion. Economic benefits may be difficult to measure, except for a few interventions, such as influenza vaccination. With chronic disease prevention strategies, economic benefits may only be realized after a significant time lag. Where employment relationships are strained and trust is low, workers may be reluctant to participate in voluntary programs. Even in stable positive work environments, many workers may feel that personal health issues are private and their employers should be uninvolved. Zealous efforts to promote health, such as through exclusive employment of nonusers of tobacco, may be seen as an unwarranted intrusion on personal autonomy.

Because of the constantly changing workplace and the nature of the workforce, some of the highest-hazard workplaces, such as in construction and mining, present unique challenges. Commercially available health promotion programs may be inadequately flexible to incorporate the particular needs of a given workforce, and small- and medium-sized employers may not have the resources to develop their own programs. Economically marginal employers may be unable to afford to design and offer programs. Workers at highest health risk—those in low-wage work—may work multiple jobs, have lengthy commutes to work, and face language or cultural barriers to participation.

Nonetheless, there is growing awareness of the importance of a healthy workforce for the overall economic health of an enterprise and, conversely, the substantial costs of ill health through absenteeism, lost productivity, and health care expenditures. This recognition is likely to increase efforts to protect, preserve, and improve worker health through workplace-specific programs that integrate occupational safety and health with overall health promotion and health management.

Bibliography

National Institute for Occupational Safety and Health. Steps to a Healthier U.S. Workforce. Available at: <http://www.cdc.gov/niosh/steps/2004/whitepapers.html>.

U.S. Preventive Services Task Force. The Guide to Clinical Preventive Services. McLean, VA: International Medical Publishing, Inc., 2002.

for proper fitting of the equipment (especially with respirators), education about proper use, and a plan for maintenance, cleaning, and replacement of equipment or parts. The costs of an effective PPE program are significant, making it particularly important to recognize that use of such equipment should be accepted only when no alternative control is present.

Administrative Measures

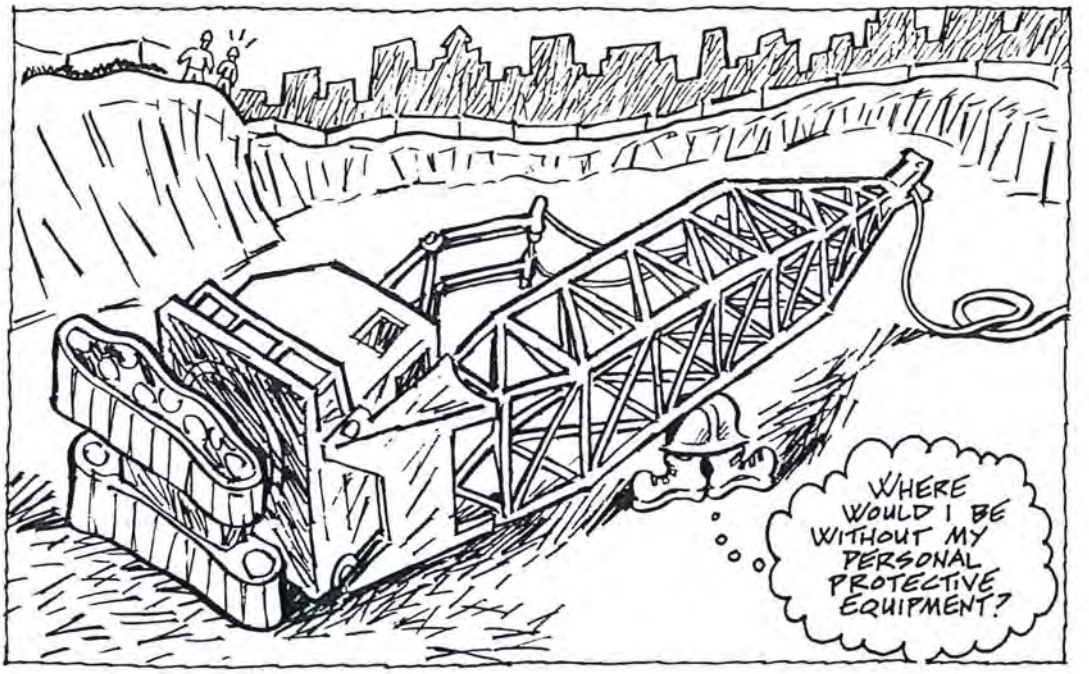
Organizational measures taken by the employer may offer some protection. For example, exposure can be reduced somewhat by implementing work schedules such that workers spend carefully limited amounts of time in areas with potential exposure. Such measures require good environmental monitoring data to design appropriate schedules. Care must be taken that the result is not simply to distribute more widely the exposure to substances that can be controlled by engineering approaches.

Another preventive administrative measure is preplacement examination to avoid assigning workers to jobs in which individual risk factors place them at higher risk for specific diseases or injuries. The requirements of the Americans with Disabilities Act in the United States place a special responsibility on those performing preplacement examinations. At a community level, zoning ordinances that restrict types of industry in residential areas or that set hours for noise restriction offer important protections.

Secondary Prevention

Screening and Surveillance

Screening and surveillance, either separately or together, may lead to the identification of need for control measures to prevent further hazardous exposure to workers (see Chapter 6). Unlike the methods described previously, which are designed to



Personal protective equipment is generally not the best approach to prevention. (Drawing by Nick Thorkelson.)

FIGURE 7-4 • Warning signs, as illustrated in this photograph, should be in multiple languages, if appropriate. (Photograph by Earl Dotter.)

BOX 7-3

Effectively Educating Workers and Communities

Margaret Quinn and Nancy Lessin

A prerequisite to effective health and safety programs is education. The most effective approach to teaching health and safety acknowledges that the worker or community member is the one most familiar with his or her job, home, and community. Workers can identify hazards, both apparent and hidden, that may be associated with their work. Community members understand the specific cultural and political characteristics that will affect the success of a program. Community and worker involvement in prioritizing educational needs and in designing and presenting training are major ingredients in making programs meaningful and useful. They should also be involved in developing and implementing solutions to health and safety problems. Education regarding solutions should include a discussion of the traditional industrial hygiene hierarchy of hazard controls, which emphasizes hazard elimination, and should not be limited to training on the use of personal protective equipment. In addition to worker and community involvement with needs assessment and program design, additional guidelines for successful educational programs include the following:

1. Develop an educational program in the trainee's literal and technical language. The educator should also understand the social context and psychosocial factors of a workplace or community environment that may affect a person's ability to participate in an educational program or to perform certain practices in response to a potential hazard.
2. Define specific and clearly stated goals for each session based on a needs assessment that has involved representatives of the workforce or community to be trained. Begin each program with a concise overview, and reinforce the key issues that come up during the session.
3. Build an evaluation mechanism that can easily be adapted to each program. The evaluation process should be designed to judge the effectiveness of the educational program in attaining goals set by both the trainer and trainees.
4. Use participatory teaching methods, which draw on the experience that workers and community member already have, in place of a traditional lecture approach.

Participatory, or learner-centered, teaching methods are designed to foster maximum worker participation and interaction. They constitute an approach to education that is based on the understanding that adults bring an enormous amount of experience to the classroom and that this experience should be used in the training program. In addition, adults learn more effectively by doing rather than listening passively. Learners' experiences are incorporated into the course material and are used to expand their grasp of new concepts and skills. Basing new knowledge on prior practical experience helps the learner solve problems and develop safe solutions to unforeseen hazards. Instructors offer specialized knowledge; workers have direct experience. It is the combination of these that leads to effective, long-lasting solutions to health and safety problems.

Participatory learning generally requires more trainer–trainee interaction than lecture-style presentations. Groups should be limited to approximately 20 participants, and these may be broken down into groups of 3 to 6 for small-group exercises. Participatory teaching methods may include use of the following techniques:

1. *Speakouts (large-group discussions)*: The participants share their experiences in relation to a particular hazard or situation.
2. *Brainstorming sessions*: The instructor poses a particular question or problem; the participants call out their ideas. The ideas are recorded on a flipchart so that they become a collective work. In this activity, the trainer elicits information from the participants rather than presenting it in a didactic manner.
3. *Buzz groups (small-group discussions or exercises)*: Each group of three to six participants discusses a particular problem, situation, or question and records the answers or views of the group.

(continued)

BOX 7-3

***Effectively Educating Workers and Communities** (Continued)*

4. *Case studies (small-group exercises)*: Participants apply new knowledge and skills in the exploration of solutions to a particular problem or situation.
5. *Discovery exercises*: Participants go back into the workplace or community to obtain certain items, such as OSHA 300 logs or records of local levels of ambient air contaminants, or perform activities, such as interviewing co-workers regarding a particular hazard; this information is brought back into the classroom for discussion.
6. *Hands-on training*: The participants practice skills such as testing respirator fit, simulating asbestos removal or hazardous waste clean-up (see Fig. 7-5), taking soil samples to measure levels of contaminants calculating lost-workday injury rates from OSHA 300 logs, or handling and learning the uses and limitations of industrial hygiene or environmental monitoring equipment.
7. *Report-back sessions*: After buzz groups, the class reconvenes as a larger group, and a spokesperson for each buzz group reports the group's answers or views; similarities and differences among groups are noted, and patterns may be discovered.

Participatory, or learner-centered, techniques are well-established methods practiced in labor education programs, schools of education, labor unions, and Committees for Occupational Safety and Health (COSH groups) and community-based environmental groups. These groups have demonstrated that it is possible to use participatory methods even for educational programs that require conveyance of specific, technical knowledge. For example, the OSHA Hazard Communication Standard has worker training requirements for use of material safety data sheets (MSDSs), which are forms that contain brief information regarding chemical and physical hazards, adverse health effects, and proper handling, storage, and personal protection for a particular substance. Training on MSDSs should cover how to obtain and interpret them, and their uses and limitations; it should give the participants practice in each of these areas. Rather than presenting the MSDS in a lecture-style format, the information can be taught more effectively with a participatory exercise, such as the one that follows.

In the first part of the exercise, workers go back into their work areas, find a labeled chemical container, and seek an MSDS for that substance. This requires workers to become familiar with where MSDSs are located in their workplace and the process required to find them. It also serves to identify problems in the system that can be corrected, such as unlabeled containers, missing MSDSs, or locked file cabinets to which no one on the shift has a key. In the second part of the exercise, the class is divided into small groups; the groups review sample MSDSs and collectively answer questions such as, "Is the substance flammable?" "What are the health effects associated with it?" "Does it require wearing of gloves?" and "What ventilation is required?" During the report-back session, the instructor asks for the answers from all of the groups and reviews how to read and interpret MSDSs in general. In the final part of the exercise, participants look up the chemicals covered in the sample MSDSs in other sources, such as the *NIOSH Pocket Guide to Chemical Hazards*. In some situations, more hazards, especially health hazards, are discovered when other sources are consulted. In this way, students learn about the uses and limitations of MSDSs and get practice in using additional sources.

Participatory or learner-centered approaches not only make learning active, but also give participants the skills and support necessary to recognize hazards and to improve health and safety conditions. These approaches broaden the objectives of worker training curricula to include learning of knowledge, attitudes, skills, and behaviors, as well as problem-solving, critical-thinking, and social-action skills.

Bibliography

Auerbach E, Wallerstein N. *ESL* for action: problem-posing at work: teachers guide and student manual. Reading, MA: Addison-Wesley, 1987.

Briggs D, Cameron B, Johnson H, et al. The evolution of worker training methods at Boeing commercial airplane group. New Solutions 1997;7:31–6.

(continued)

BOX 7-3

Effectively Educating Workers and Communities *(continued)*

FIGURE 7-5 • Hands-on field training for hazardous waste workers.

Cary M, Van Belle G, Morris SI, et al. The role of worker participation in effective training. New Solutions 1997;7:23–30.

Colligan M. (Ed.). Occupational safety and health training. Occup Med: State of Art Rev 1994;9(2):127–361.

Hecker S. Education and training. In: JM Stellman, ed. ILO encyclopaedia of occupational health and safety. Geneva: International Labor Organization, 1998:18.1–18.32.

McQuiston T, Coleman P, Wallerstein N, et al. Hazardous waste worker education. J Occup Med 1994;36:1310–23.

Massachusetts Coalition for Occupational Safety and Health. English as a second language health and safety curriculum for working people. Boston: Mass-COSH, 1993.

National Clearinghouse for Worker Safety and Health Training for Hazardous Materials, Waste Operations and Emergency Response, National Institute of Environmental Health Sciences (NIEHS), 5107 Benton Avenue, Bethesda, MD 20814 (telephone 301-571-4226). Materials available from all NIEHS regional training centers, including *Chemical and radioactive hazardous material workbook* (Oil, Chemical and Atomic Workers/Labor Institute, New York, 1993) and *Hazardous waste workers health and safety training manual, version 3.1* (The New England Consortium, University of Massachusetts Lowell, Lowell, MA, 1997).

Slatin C, ed. Health and safety training [special section]. New Solutions 1995;5(2):4–38.

The Labor Institute. Sexual harassment at work: a training workbook for working people. New York: The Labor Institute, 1994.

Wallerstein N, Pillar C, Baker R. Labor educator's health and safety manual. Berkeley, CA: Labor Occupational Health Program, Center for Labor Research and Education, Institute of Industrial Relations, University of California, 1981.

Wallerstein N, Rubenstein H. Teaching about job hazards: a guide for workers and their health providers. Washington, DC: American Public Health Association, 1993.

Wallerstein N, Weinger M, eds. Empowerment education [special issue]. Am J Ind Med 1992;22(5):619–784.

prevent occurrence of occupational disease or injury by primary prevention, screening and surveillance activities are part of secondary prevention. Both screening and surveillance are directed toward identification of health events or documentation of early evidence for adverse health effects that have already occurred. *Screening* is a clinical activity that seeks to identify adverse health effects in an individual before they are symptomatic and when intervention can reduce the probability the individual will develop an adverse health outcome. Specific guidelines for appropriate screening

include considerations of risks and benefits to the individual. (See Chapters 6 and 12.) Screening may identify individuals who need primary workplace intervention or who need specific treatment or other therapeutic intervention. *Surveillance* is the systematic gathering, analysis, and dissemination of data. It implies watching out or watching over and may consist of watching out for single events (*sentinel events*) that signal a breakdown in prevention or may consist of reviewing grouped or aggregate data for subtle trends that may be significant across a population but not meaningful for a specific individual (such as increases in liver enzymes that do not exceed population norms). Surveillance can lead to primary prevention measures by identifying inadequate control measures, allowing them to be corrected.

By recognizing potential or existing work-related disease or injury, health professionals can initiate activities leading to one or more of these methods of prevention. They can play an active role in education by informing the community about potentially hazardous workplace exposures and ways of minimizing them. They can advise appropriate use of respirators or other PPE. They can also develop appropriate screening programs targeting high-risk workers or community members. Consultation with specialists in occupational medicine, occupational hygiene, toxicology, safety, or ergonomics may be necessary to facilitate these activities.

Roles in Environmental Health

Roles for professionals in environmental health have been developed by CDC in collaboration with stakeholders at state and local levels and are intended to guide the development of the public health workforce.[5] They can be categorized as follows:

Assessment

Research. Identifying and compiling relevant information to solve a problem and obtaining the relevant information.

Data Analysis and Interpretation. Analyzing data, recognizing meaningful test results, interpreting results, and presenting the results in a meaningful way to different types of audiences

Advice to employees and employers should be practical. (Drawing by Nick Thorkelson.)

Evaluation. Evaluating the effectiveness or performance of procedures, interventions, and programs.

Management

Problem-solving. Understanding and solving problems.

Economic and Political Issues. Understanding and appropriately using information about the economic and political implications of decisions.

Organizational Knowledge and Behavior. Functioning effectively within the culture of organizations and be an effective team player.

Program and Project Management. Planning, implementing, and maintaining fiscally responsible programs and projects using skills and prioritizing projects across the employee's entire workload.

Computer Use/Information Technology. Using information technology as needed to produce work products.

Reporting, Documentation, and Record-keeping. Producing reports to document actions, keep records, and inform appropriate parties.

A B

FIGURE 7-6 • **(A)** Spray painter with respiratory protection. **(B)** Makeshift PPE. Cotton plugs are not effective as PPE; only adequately fitting earplugs or earmuffs are effective. (Photographs by Earl Dotter.)

Collaboration. Forming partnerships and alliances with other individuals and organizations to enhance performance on the job.

Communication

Education. Using environmental health practitioners' frontline role to effectively educate the public on environmental health issues.

Communication. Effectively communicating risk and exchanging information with colleagues, practitioners, clients, policymakers, interest groups, the news media, and the public through public speaking, print and electronic media, and interpersonal relations.

Conflict Resolution. Facilitating resolution of conflicts within an agency, in the community, and with regulated parties.

Marketing. Articulating basic concepts of environmental health and public health and conveying an understanding of their value and importance to clients and the public.

Roles of the Clinician

Once a clinician has identified a probable case of occupational or environmental disease or injury, it is crucial to take preventive action while also providing appropriate treatment and rehabilitation services. Failure to consider the prevention opportunities along with the necessary therapeutic measures may lead to recurrence or worsening of the disease or injury in the affected worker and the continuation or new occurrence of similar cases among workers in similar jobs, either at the same workplace or at other workplaces. A clinician has at least the following five opportunities for preventive action after identifying a case of work-related disease or injury:

- Advise the patient
- Contact the patient's union or other labor organization
- Contact the patient's employer
- Inform the appropriate government authority, and
- Contact an appropriate research or expert group.

Often, some combination of these approaches is undertaken.

Advise the Patient

The clinician should always advise the patient concerning the nature and prognosis of the condition; the possibility that there may be appropriate engineering controls to remove the hazard, such as removing lead-based paint in the home; the need, even if only temporarily, for PPE at work; or, in extreme circumstances, the necessity to change jobs or to move to a different home. The clinician should alert the patient to the need to file a workers' compensation report to protect the worker's rights to

income replacement and both medical and rehabilitation services (see Chapter 4). These reports also trigger the employer to consider listing the health event as a reportable injury or illness and may lead the insurance carrier to provide consultative services to the employer to assess the problem area and consider appropriate control measures.

At times, the clinician may be called on to provide advice to the patient concerning legal remedies should a health problem result in a contested workers' compensation claim or the need for registering a complaint with an appropriate government agency (see below). Options may be limited; the worker may not wish to file a claim or register a complaint, fearing job loss or other punitive action, or a family may not have the resources to move to a better home. However, it is essential to inform the patient of potential hazards. It is not appropriate to withhold this information because of the possibility of upsetting the patient. A clinician cannot assume that even a large and relatively sophisticated employer has adequately educated its workers about workplace hazards. Once a patient is informed of the work-relatedness of a disease in writing, this may start the time clock on notification procedures and statutes of limitations for workers' compensation (see Chapter 4).

Contact the Patient's Union or Other Labor Organization

If it is agreeable to the affected worker, the health professional should inform the appropriate labor organization of the health hazards suspected to exist in the workplace. The provision of this information may help to alert other workers to a potential workplace hazard, facilitate investigation of the problem, identify additional similar cases, and eventually facilitate implementation of any necessary control measures. (Keep in mind, however, that fewer than 15 percent of workers in the United States belong to a union.)

Contact the Patient's Employer

The clinician, again only with the patient's consent, should report the problem to the employer. This can be effective in initiating preventive action. Many employers do not have the staff to deal with reported problems adequately, but they can obtain assistance from insurance carriers, government agencies, academic institutions, or private firms. In addition to triggering workplace-based prevention activity, discussions with the employer may lead to obtaining useful information concerning exposures and the possibility of similar cases among other workers. Depending on the circumstance, it can be particularly helpful to the health professional to arrange with an employer to visit a patient's work area. This presents the opportunity to observe the possibly hazardous environment firsthand and to establish the necessary rapport with managers to involve them in prevention.

Although the law prohibits employers from firing workers for making complaints to OSHA, it does not prohibit them from firing workers who have a potentially work-related diagnosis. In the United States, only the OSHA lead and cotton dust standards mandate removal of workers from jobs that are making them sick. The medical removal protection section of the OSHA lead standard provides temporary medical removal for workers at risk of health impairment from continued lead exposure, as well as temporary economic protection for workers so removed. It states, "During the period of removal, the employer must maintain the worker's earnings, seniority and other employment rights and benefits as though the worker had not been removed." (See Chapters 13, 26, and 30 for more information on lead.) The cotton dust standard does not offer such protection.

Important is close cooperation between labor and management, such as that demonstrated by health and safety committees (Box 7-4).

Inform the Appropriate Governmental Regulatory Agency

If a case of occupational or environmental disease or injury appears to be serious or may be affecting other workers in the same workplace, company, or industry or individuals in the same community, it is wise for the patient or the health professional to consider filing a complaint with the appropriate governmental agency, such as OSHA, EPA, or the state or local health department. (See Chapter 3.) State and local health departments depend on clinicians to identify new clusters of disease, such as foodborne illness, so they can investigate and control these outbreaks.

The health professional should always inform the patient in advance of notifying federal or state governmental agencies. Although regulations of OSHA and the Mine Safety and Health Administration (MSHA) protect U.S. workers who file health and safety complaints against resultant discrimination by the employer (loss of job, earnings, or

BOX 7-4

Labor–Management Health and Safety Committees

The benefits that accrue from seeking the participation of labor unions and workers in the development and implementation of occupational health and safety programs and research can be substantial. As a consequence of their experience and intimate knowledge of the actual work processes, workers and their unions often can add significantly to the understanding of a health or safety problem and determine the best approach to prevention of risks. Their participation also aids in understanding and explaining the nature and importance of programs and research efforts and in interpreting the impact and meaning of such work to individual workers (Fig. 7-7).

One effective means for including workers and their labor unions in the development and improvement of approaches to prevention is joint labor–management health and safety committees in the workplace. These committees consist of representatives of workers and managers. They meet periodically to systematically review workplace health and safety hazards and their control and to respond to specific complaints concerning workplace health and safety. For these committees to function effectively, labor representatives must be truly representative of workers and not simply appointed by management.

Joint labor–management health and safety committees have been legally authorized and are more generally active in some countries, such as Canada. In the United States, they are less common and usually are established through collectively bargained agreements. Proposed OSHA reform legislation in the United States would require operation of health and safety committees in many more workplaces than at present.

Studies in Canada, where joint health and safety committees have been mandated, suggest that this particular form of involvement can be unusually effective. Reduction in work injuries and resolution of health and safety problems without the need for governmental intervention have been documented. Effective committees tend to have cochairs and equal representation, readily available training and information, and well-established procedures. An important feature of successful committees is sufficient authority for action, either as a committee or on the part of the management representatives.

Typically, labor–management health and safety committees meet on a monthly basis for 1 to 2 hours. They review, evaluate, and respond to worker and manager complaints and concerns about working conditions and workplace hazards. They periodically walk through the workplace to observe and assess working conditions and possible health and safety hazards. In addition, they systematically evaluate work practices and procedures and materials used in the workplace in regard to their impacts on workplace health and safety.

As effective as labor–management health and safety committees can be, they are most effective when seen as one component of a more general prevention program that also relies on the development and enforcement of government regulations.

benefits), this protection is difficult to enforce, and workers' fears are not unfounded. Health professionals should familiarize themselves with pertinent laws and regulations. For example, if the worker does not file an "11(c)" (antidiscrimination) complaint within 30 days of a discriminatory act, the worker's rights are lost. In the United States, health professionals and workers (or their union, if one exists) have the right, guaranteed by the Freedom of Information Act, to obtain the results of an OSHA inspection.

Help to Create New Knowledge

Occasionally, the health professional who is reporting a work-related or environmentally-mediated medical problem may undertake or assist in a research investigation of this problem. No matter who conducts the research, investigation of the workplace and identification and analysis of additional cases often lead to new information. Publication of epidemiologic studies or case reports alerts others to newly discovered hazards and ways of controlling them. The health professional may also assist

FIGURE 7-7 • Joint labor–management health and safety committees are increasingly important in ongoing workplace prevention activity. **(A)** Medical monitoring, screening programs, and a wide variety of other occupational health issues are discussed by committee. **(B)** A worker points out a faulty oil line in a grinder to the union health and safety representative (man in white shirt). (Photograph by Earl Dotter.)

with research to evaluate the effectiveness of preventive approaches, such as the impact of OSHA regulations.

Other Available Resources

Additional resources may be available through federal, state, and local governmental agencies, as well as academic centers and professional organizations. There is a wealth of information on the Web sites of many of the following groups, but it is helpful to know the focus of each as well as their relative strengths and limitations and to be clear to individuals or community groups about the potential costs as well as benefits of engaging each.

The Association of Occupational and Environmental Clinics (AOEC)

A nonprofit association of 60 clinics and more than 250 occupational and environmental health professionals that are dedicated to improving the provision of occupational and environmental health care through information sharing and research, this is one of the most useful resources. AOEC has entered into cooperative agreements with both NIOSH and ATSDR (below) and funds members to participate in specific activities, such as providing services to populations near specific hazardous sites or developing learning materials that can be downloaded and presented for courses and education programs. Member clinics, which are often based in large academic medical centers, must provide access to industrial hygiene and other preventive services. Through AOEC, one can often identify physicians or other health care professionals with specific clinical or research expertise, either for patient referral or for consultation by telephone with the treating physician. (It is in the best interest of the patient to have a therapeutic relationship with a health care provider—a relationship that cannot be established over the telephone.)

The National Center for Environmental Health (NCEH) and the Agency for Toxic Substances Disease Registry (ATSDR)

NCEH and ATSDR have recently been administratively merged at CDC. ATSDR was created by congressional mandate to address health concerns arising from chemical pollution at Superfund sites. Its mission is to assess and mitigate the effect on public health of hazardous substances in the environment. It provides public health assessments of waste sites, health consultations concerning specific hazardous substances, health surveillance and registries, response to emergency releases of hazardous substances, applied research in support of public health assessments, information development and dissemination, and education and training concerning hazardous substances. ATSDR does not conduct formal surveillance or screening, but under unusual circumstances (such as in Libby, Montana), it may contract with AOEC member clinics or other health care providers. ATSDR has also evaluated neurologic and other outcomes among occupants of a building converted from industrial use that was subsequently found to be heavily contaminated with metallic mercury, conducted investigations of unlicensed pesticide applicators using methyl parathion illegally for indoor pest control, and done preliminary studies into complaints

arising from low-frequency noise exposure. ATSDR is obligated to formally respond to written citizen requests. Information about the complaint process is available on its Web site, <www.atsdr.gov>.

NCEH provides technical assistance at the request of state or local health departments. It helps to prevent or control diseases or deaths resulting from interactions between people and their environment, including but not limited to those due to chemicals. For example, it also addresses hazards and impediments to walking and bicycling introduced by poor urban planning. Its divisions and offices:

- Provide national and international leadership for coordinating, delivering, and evaluating emergency and environmental public health services;
- Focus on air pollution and respiratory health, environmental surveillance, health studies of disasters and emerging threats, and radiologic hazards;
- Respond to requests from state and local public health departments, such as by helping to evaluate the health impact of a chemical spill on the surrounding community;
- Develop and measure biomarkers for environmental exposures;
- Issue periodic reports with information on the distribution and amount of chemicals in urine and blood in a sample of the U.S. population, such as lead and cotinine, and phthalates;
- Coordinate research and provide information on human genomic discoveries that may be applied to disease prevention; and
- Provide research and technical assistance to reduce the burden of environmental hazards internationally.

The OSHA Small Business Consultation Program

In addition to developing and enforcing standards, OSHA funds a system of consultation programs throughout the United States, based in agencies and universities that provide, on request, free occupational safety and health consultation primarily to businesses with fewer than 250 employees. These programs provide workplace walkthrough surveys, obtain industrial hygiene measurements, and provide recommendations. Although these programs do not impose OSHA fines or citations, if serious hazards are encountered in the course of an evaluation, the program is obligated to inform the local OSHA office (similar to the responsibilities of the NIOSH Health Hazard Evaluation program, described below and in Chapter 33). This program is designed to assist small businesses that do not have the resources to provide sophisticated health and safety services—although it does not reduce the employer's responsibilities. The program is most effective for those hazards that are well understood and for which OSHA standards exist, such as noise, asbestos, and general safety. In general, these programs are small. There may be a significant wait before the evaluation takes place and a longer one before it is completed. If there are serious, immediate hazards at a workplace, the best approach is still to contact the local OSHA office. However, if a health care provider is treating a patient who works for a small business where the employer is trying to do the right thing, this can be a valuable resource.

The National Institute for Occupational Safety and Health (NIOSH)

Although the Occupational Safety and Health Act of 1970 created them both, NIOSH and OSHA are distinct agencies with separate responsibilities. OSHA is part of the U.S. Department of Labor and is responsible for creating and enforcing workplace safety and health regulations. NIOSH, which is part of the CDC in the Department of Health and Human Services, is responsible for conducting and supporting research to improve workplace safety and health, promoting and supporting training in occupational safety and health, providing technical assistance to employers and employees (often in the form of health hazard evaluations), and developing the scientific basis for standards or other policies aimed at improving workplace safety and health.

NIOSH responds to requests for investigations of workplace hazards through its Health Hazard Evaluation (HHE) program (see Chapter 33). An HHE is a worksite study designed to evaluate potential workplace health hazards. HHEs can be requested by a management official, three current employees, or any officer of a labor union representing the employee. However, with the employee's consent, a health care professional can also contact NIOSH and speak with members of the HHE program. Although there are specific regulations that guide the HHE program itself, NIOSH places a high priority on identifying and preventing emerging threats. HHEs are often able to develop the state of the science, such as identifying outdoor sources of fatal carbon monoxide poisoning; establishing, identifying probable causes, and documenting

successful interventions for exposures causing corneal edema; or evaluating fixed small airways disease in a popcorn packaging plant. NIOSH HHEs also result in new exposure assessment methods; for example, they developed the first validated measure of aerosolized pentamidine in clinical settings and established the limitations of dry cotton swabs in measuring environmental anthrax contamination. Because of limited resources, the NIOSH HHE program will not conduct evaluations for known hazards, such as noise or indoor air quality problems, but will instead typically provide written information to the requestor. When an evaluation is conducted, NIOSH reports the results to the workers, the employer, and the U.S. Department of Labor and makes recommendations for reduction or removal of the hazard. Although the HHE program serves as a useful surveillance tool for keeping NIOSH abreast of emerging workplace concerns, NIOSH conducts a wide range of additional surveillance activities to determine the number of workers exposed to specific hazards and which industries and occupations are at risk.

NIOSH supports research through (a) intramural programs that it conducts, (b) cooperative agreements that it initiates and in which it participates, and (c) research grants that extramural investigators initiate and conduct. In 1996, NIOSH established the National Occupational Research Agenda (NORA), a framework to guide occupational safety and health research—not only for NIOSH, but for the occupational health and safety community at large.

To disseminate research findings, NIOSH publishes a variety of reports and other materials. NIOSH publications are designed to inform workers, employers, and occupational safety and health professionals of hazards and how to avoid them.

NIOSH has headquarters in Washington, DC, with administrative offices in Atlanta and with six working divisions and one office located in Morgantown and Cincinnati, two laboratories in Pittsburgh, one laboratory in Spokane, and field stations in Denver and in Anchorage. These major units are

The Division of Applied Research and Technology (DART), which conducts research in toxicology, neurologic and behavioral science, and ergonomics. Responsibilities include laboratory and field studies of biomechanical, psychological, neurobehavioral, and physiologic effects of physical, psychological, biomechanical, and selected chemical stressors. It also develops biological monitoring and diagnostic procedures to improve worker health and conducts research to develop procedures and equipment for the measurement of occupational safety and health hazards and for the development of effective engineering controls and work practices. It also maintains a quality control reference program for industrial hygiene laboratories.

The Division of Respiratory Disease Studies (DRDS), which conducts epidemiologic, environmental, clinical, and laboratory research focusing on all aspects of occupational respiratory disease. It also has specific responsibilities from the Mine Safety and Health Act (the National Coal Workers X-ray Surveillance and the National Coal Workers Autopsy Study, certification of x-ray facilities, mine plan approvals, and B-reader examinations).

The Division of Safety Research (DSR), which conducts research on occupational injury prevention through studies of risk factors and the effectiveness of prevention efforts. It conducts research to provide criteria for improving personal protective equipment and devices.

The Education and Information Division (EID), which has responsibility for development of NIOSH policy and recommendations, with special attention to new occupational health and safety standards. It publishes *Current Intelligence Bulletins* to disseminate new scientific information and *Alerts* to identify opportunities for preventative interventions. It also undertakes quantitative risk assessment efforts to prioritize issues for regulatory attention. It provides library services and technical information services, maintains the NIOSH archives, and operates a toll-free telephone information line.

The Division of Surveillance, Hazard Evaluations and Field Studies (DSHEFS), which has responsibility for surveillance of the extent of hazards and occupational illnesses. It conducts legislatively mandated health hazard evaluations at the request of employees or employers. It also conducts a broad range of industrywide epidemiologic and industrial hygiene research programs, with wide responsibility for occupational illnesses not included in DART or DRDS. It is also responsible for energy-related health research related to workers at U.S. Department of Energy facilities.

The Health Effects Laboratory Division (HELD), which conducts basic, applied, and preventive laboratory research, develops intervention programs, and designs and implements methods for health communications in the area of occupational injury and disease. HELD collaborates with researchers throughout NIOSH and in other public and private institutions to apply the latest scientific research to workplace health problems

The National Personal Protective Technology Laboratory (NPPTL), which focuses expertise from many scientific disciplines to advance federal research on respirators and other personal protective technologies for workers.

The Pittsburgh Research Laboratory and the Spokane Research Laboratory, which conduct surveillance, research, intervention development, technology transfer and training methods development aimed at reducing illness and injuries in the mining industry.

The Office of Compensation Analysis and Support, which conducts activities to assist claimants and support the role of the Secretary of Health and Human Services under the Energy Employees Occupational Illness Compensation Program Act of 2000.

To further assist professionals and the public, NIOSH provides a toll-free information system. It can be accessed by telephone at 1-800-35-NIOSH (1-800-356-4674). NIOSH specialists provide technical advice and information on subjects in occupational safety and health.

State and Local Resources

In addition to those states where there is a state OSHA plan, each state has a state public health department, as do many counties and many large cities. Basic functions of public health departments include disease surveillance, environmental assessment, and preventive services, although the scope of these varies widely according to state history and funding. Public health departments nationally suffered neglect and decay of human resources and infrastructure as a victim of their own successes in allowing Americans to take clean water and safe food supplies for granted. Even the renewed attention to infectious diseases that took place in the wake of the AIDS pandemic and the advent of multiple drug resistant tuberculosis sparked more of a medical response, with some increased attention paid to services for sexually transmitted diseases and public health messages. Since the September 11 terrorist attacks and the subsequent anthrax outbreak, renewed attention has been given to improving disaster preparedness in the public health system, recognizing the depleted public health infrastructure.

Public health departments generally include some aspects of environmental control or sanitation, and many have programs specifically directed toward childhood lead screening programs. Some include other housing needs, such as radon detection, window safety, and water incursion, although in some locations these programs are located in a department of housing. Control of vectors, including rats, mosquitoes, and other pests, is an additional responsibility of many health departments. State departments of environmental health or environmental resources are tasked with many of the enforcement responsibilities required by specific EPA regulations, although there is growing recognition of the need for regional collaboration among states for many of these responsibilities. These state-level departments or the EPA, for example, may provide information about certified laboratories for specific environmental testing programs. Some state health departments, such as Massachusetts, New Jersey, Wisconsin, and California, have very strong components addressing occupational safety and health. Major cities, such as Chicago, New York, Washington, D.C., and Los Angeles, have strong environmental health units within their public health departments. State, county, and municipal Web sites are useful sources of information. Governmental services are also listed in the blue pages of the telephone book.

Education and Research Centers, Environmental Health Sciences Centers, and Outreach and Training Programs

NIOSH currently funds 16 comprehensive Education and Research Centers (ERCs) that focus on occupational safety and health professional training but that also provide continuing education and research training. They are a useful source of academic expertise and may be able to fund small pilot research projects to permit a preliminary investigation into a new or emerging hazard. The National Institute of Environmental Health Sciences is part of the National Institutes of Health and funds research and training in environmental health, including 20 university-based Environmental Health Sciences Centers, all of which have community

outreach and educational components, as do five Marine and Freshwater Biomedical Sciences Centers and one Developmental Center. Although attempting to identify faculty research expertise that meets a local community need is usually hit or miss, at a minimum the effort provides insight into the nearby academic expertise. NIEHS also funds worker education programs related to hazardous materials and K–12 environmental health education science curricula.

The Environmental Protection Agency

Although EPA is primarily a regulatory agency, it also has research and laboratory facilities, training and outreach programs, and environmental justice initiatives that may provide expertise and technical assistance.

RESOURCES ON THE WEB

The CDC Web site includes information on environmental and occupational health, injury prevention, and other aspects of public health. Issues of the *Morbidity and Mortality Weekly Report* are available online and cover major public health issues as well as current investigations (see <http://www.cdc.gov/node.do/id/0900f3ec8000e044>).

Environmental Health Perspectives, a print journal that is fully available online, is published monthly by the National Institute of Environmental Health Sciences, part of the NIH (see <http://ehp.niehs.nih.gov/>).

The EPA Web site includes tools to identify contaminant sources at the neighborhood level ("Enviromapper"), Toxic Release Inventory information, and real-time air pollution mapping, among other resources (see <http://www.epa.gov/>).

The NIOSH site is especially useful for educational and research materials, as well as information about Health Hazard Evaluations (see <http://www.cdc.gov/niosh/homepage.html>).

The OSHA home page includes exceptionally helpful links to technical topics, as well as information on state programs, standards, and enforcement (see <http://www.osha.gov/>).

REFERENCES

1. Held E, Mygind K, Wolff C, et al. Prevention of work related skin problems: An intervention study in wet work employees. Occup Environ Med 2002;59:556–61.
2. Evanoff BA, Bohr PC, Wold LD. Effects of a participatory ergonomics team among hospital orderlies. Am J Industr Med 1999;35:358–65.
3. Carayon P, Smith M. Work organization and ergonomics. Appl Ergon 2000;31:649–62.
4. Centers for Disease Control and Prevention. Third national report on human exposure to environmental chemicals. Atlanta, GA: CDC, 2005. Available at: <http://www.cdc.gov/exposurereport>.
5. Centers for Disease Control and Prevention. A national strategy to revitalize environmental public health services. Available at: <http://www.cdc.gov/nceh/ehs/Docs/NationalStrategy2003.pdf>.

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.

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OCCUPATIONAL AND ENVIRONMENTAL HEALTH

RECOGNIZING AND PREVENTING DISEASE AND INJURY

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