CHAPTER 6

Recognizing Occupational and Environmental Disease and Injury

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To prevent occupational and environmental disease and injury effectively, health professionals must know how to anticipate and recognize conditions in those who present with symptoms and those who are presymptomatic. Health professionals can also recognize abnormal trends by examining grouped data. A systematic approach facilitates consideration of all aspects of prevention in reducing or eliminating occupational hazards.

This chapter is organized to highlight the three levels of recognition that serve the three levels of prevention:

1. *Primary prevention* is designed to deter or avoid the occurrence of disease or injury.
2. *Secondary prevention* is designed to identify and adequately treat a disease or injury process as soon as possible, often before any symptoms have developed.
3. *Tertiary prevention* is designed to treat a disorder when it has advanced beyond its early stages to avoid complications and limit disability, or, if the condition is too advanced, to address rehabilitative and palliative needs.

The correct diagnosis and approach to treatment of a person with an occupational or environmental illness or injury is essential to maximize opportunities for tertiary prevention. It can also promote primary and secondary prevention. A carefully designed surveillance program, using both case- and rate-based approaches, promotes primary prevention. The selection and use of screening and monitoring tests that are appropriate to identify risks promotes secondary prevention.

When properly planned and integrated, these approaches contribute to (a) controlling risks at the source, (b) identifying new risks at the earliest possible time, (c) delivering the best level of therapeutic care and rehabilitation for those who are ill or injured, (d) preventing recurrence of disease and injury of affected people and occurrence of disease and injury in others who are exposed to similar risks, (e) ensuring that those affected receive economic compensation legally due them, and (f) discovering new relationships between occupational and environmental exposures and disease.

The remainder of this textbook provides necessary information needed to anticipate, recognize, and prevent disease and injury. This chapter introduces a systematic approach for the health professional to recognize occupational and environmental disease and injury, with an eye toward prevention.

GATHERING CLINICAL INFORMATION

Obtaining a history about external exposures serves four major functions in clinical practice:

1. It helps the clinician understand patients in the context of their lives.
2. It can help shape routine anticipatory guidance for well-child care or routine adult care. (For example, while all smokers are counseled to quit cigarette smoking, the clinician may enhance

success by discussing specific risks for smokers' children or for smokers with prior workplace asbestos exposure.)
3. It can assist clinicians in providing specific advice about work, community, or home exposures.
4. Finally, it can assist in the diagnosis.

Certain types of conditions and circumstances require more in-depth approaches than others. Sometimes a brief inquiry will suffice. For example, the evaluation of a patient with mild low back pain might require only a brief inquiry into precipitating factors; however, the clinician may be able to play an important preventive role through workplace modification (see Chapters 11 and 23).

Proper diagnosis of illness or injury requires information from a variety of sources. Successful identification of an association with an occupational or environmental factor rarely results from a single laboratory test or diagnostic procedure but rather depends critically on a comprehensive and appropriate patient history that adequately explores the relation of the illness to the occupational and environmental exposures and conditions. Health professionals have a vital role in recognizing occupational and environmental disease.

The Occupational and Environmental Histories

Consider the following five cases:

1. A machinist was noted by his supervisor to have loss of balance on the job and was diagnosed at a nearby emergency department as being acutely intoxicated with alcohol.
2. A garment worker was told by her primary care physician that the numbness and weakness in some of her fingers was caused by her rheumatoid arthritis.
3. A man working at a bottle-making factory was told by his internist that the worsening of his chronic cough was caused by cigarette smoking.
4. A 6-year-old boy was noted by his parents as having learning difficulties in school, which were attributed by his physician to borderline mental retardation.
5. A 10-year-old girl was brought to her pediatrician with a severe exacerbation of her asthma, which the pediatrician attributed to a viral infection.

In each of these situations, the physician made a reasonable and considered evaluation and diagnosis. The facts fit together and resulted in a coherent story, leading each physician to recommend a specific therapeutic and preventive regimen. In each of these cases, however, the physician made an inadequate or incorrect diagnosis because of a common oversight—failure to take occupational and environmental histories.

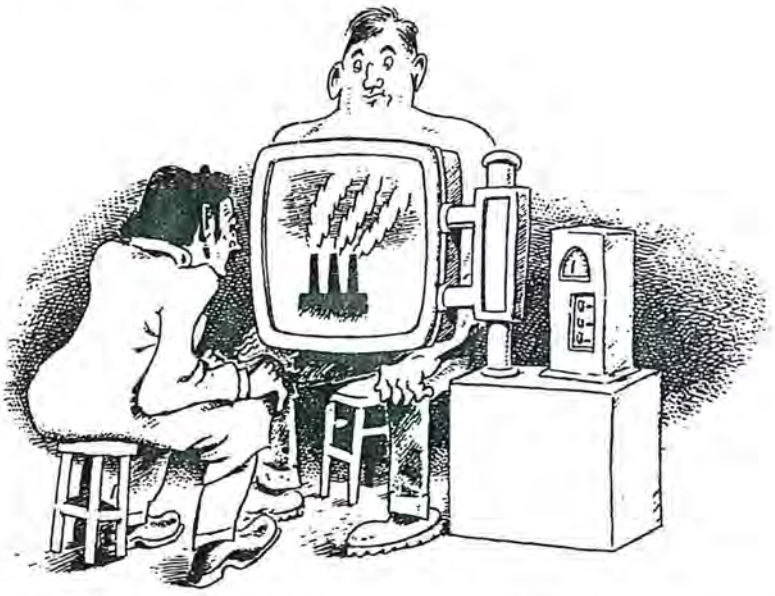
The first patient had acute central nervous system (CNS) intoxication caused by exposure to organic solvents at work. The garment worker had carpal tunnel syndrome, possibly caused by some combination of her rheumatoid arthritis and the strenuous repetitive movements she performed with her hands and wrists hundreds of times an hour. The man working in the bottle-making factory had worsening of his chronic cough and other respiratory tract symptoms as a result of exposure to hydrochloric acid fumes at work. The young boy had lead poisoning due to dust from leaded paint in his home. And the young girl had asthma due to mold in her home as a result of water damage.

This is not to say that the associations noted by the physicians were unrelated to the conditions diagnosed. They may have been contributory in the second, third, and fifth cases, but without occupational and environmental histories, proper therapy and prevention could not be planned.

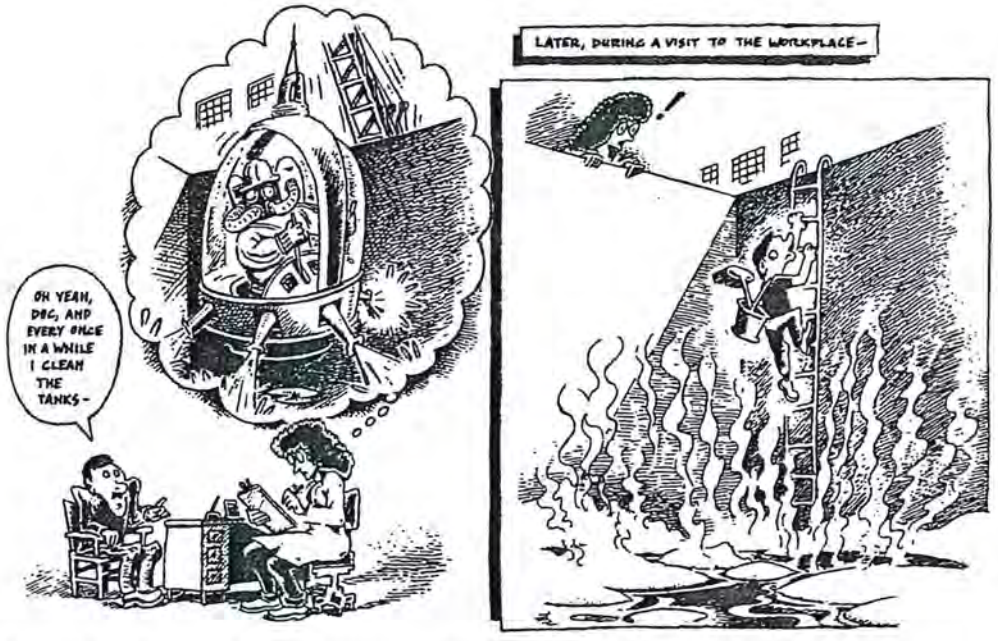
The identification of occupational and environmental health problems depends most importantly on occupational and environmental histories. Physical examination findings and laboratory test results may sometimes raise suspicion or help confirm that a medical problem is related to occupational and environmental factors, but ultimately it is information obtained from occupational and environmental histories that determines the likelihood that this is the case.

WHAT QUESTIONS TO ASK

The occupational and environmental histories are outlined in Tables 6-1 and 6-2. Most clinical situations do not require obtaining complete occupational and environmental histories. Health professionals need to exercise judgment in choosing which questions to ask. A question or two in the psychosocial section of the medical history is not enough; the clinician should obtain information, as he or she deems appropriate, on the current and



Physicians and other health professionals have a vital role in recognizing occupational disease. Contrary to the drawing above, there is no simple test. The suspicion and the determination of work-relatedness depend primarily on a careful occupational history. (Drawing by Nick Thorkelson.)



It is crucial to clearly understand working conditions and exposures. (Drawing by Nick Thorkelson.)

TABLE 6-1

Outline of a Detailed Occupational History

Components	Specific Questions and Issues
Description of all jobs held	Employers, details of jobs, and starting and ending dates of each job.
	Second jobs, work in the home as a homemaker or parent, military service, and part-time and summer jobs.
	Description of typical workshift.
	Simulated performance of work tasks by demonstrating body movements associated with them. (Visiting the workplace may be necessary.)
	Routine tasks as well as unusual and overtime tasks, such as cleaning out tanks or cleaning up spills.
Exposures	Chemical, physical, biological, biomechanical, and psychosocial exposures at workplaces. Start with open-ended questions, such as "What have you worked with?" Follow with specific questions, such as "Were you ever exposed to lead or other heavy metals? To solvents? To asbestos?" Obtain material safety data sheets (MSDSs) for workplace chemicals.
	Tasks performed in adjacent areas of the workplace that may contribute to a worker's exposure.
	Unusual incidents, such as spills of hazardous materials, work in confined spaces (Fig. 6-1), use of new substances, and changed processes at work.
	Quantification of exposures to the extent feasible, usually by estimating concentration, and determining duration of exposure and route of entry.
	Presence of protective engineering systems and devices, such as ventilation systems, and whether they seem to function adequately.
	Use of personal protective equipment, such as gloves, workclothes, masks, respirators, and hearing protectors.
	Eating, drinking, and smoking in the workplace (Fig. 6-2).
	Handwashing and showering at work, changing of workclothes, and cleaning of workclothes.
Timing of symptoms	Time course of symptoms in relation to exposures.
	Time symptoms begin and end in relation to workshifts.
	Presence of symptoms during weekends and vacation periods.
	Relation of symptoms to certain processes, work tasks, or work exposures.
Symptoms among co-workers	Whether other workers at the same workplace or in similar jobs elsewhere have the same symptoms or illnesses. If so, what they may share in common.
Nonwork exposures	Pertinent questions from the environmental history (see Table 6-2).

TABLE 6-2

Outline of a Detailed Environmental History

Components	Specific Questions and Issues
Present and prior home locations	Information on all places that a person has lived. In particular, one should ask about living hear to: (a) an industrial facility that may be polluting the air, surface water, groundwater, or the soil; (b) a hazardous waste site; and (c) a farm where pesticides or herbicides may have been applied.
Jobs of household members	Workers may bring home contaminants, such as lead. Children may be inappropriately brought to a worksite, such as a farm where pesticides have been used.
Environmental tobacco smoke	Smokers in home and other environments.
Lead exposure	Is a child living in a home built before 1978?
	Does a child have a sibling or playmate with a history of lead poisoning?
	Is lead present in water pipes?
	Is there imported pottery in the home?
	Are ethnic folk remedies used?
	Do household members work in lead-related industries or have hobbies in which they are exposed to lead?
Home insulating, heating, and cooking	What types of insulation are present?
	Are furnaces and stoves properly vented?
Household building materials	What types have been used? For example, formaldehyde-containing materials may cause irritative and respiratory symptoms. Has there been recent renovation or remodeling?
Home cleaning agents and other household products	What types have been used? Many household products contain toxic, allergenic, or irritant chemicals.
Presence of pests, mold, pets, and dust in the home	Asthmatic and other atopic individuals may be allergic to cockroaches, molds, animal dander, or dust mites. Is there a damp basement or recent flooding that might be conducive to mold growth? Are there pillows and stuffed animals, which can be a reservoir for house dust mites? Are there shag carpets, which can be a reservoir for allergens?
Pesticide usage	What types have been used and where? Do not overlook flea collars and flea treatments of pets.
Water supply	What is the source of water? People on small water systems or with private wells are especially at risk. Bottled water may not be safer than municipal water. If people are using a private well, when was it last tested?
Diet	Obtain information on diet, including dietary supplements. If there has been a possible foodborne illness, what food was eaten and what was its source during the time of likely exposure? Was lead-glazed pottery used for food preparation?
Hobbies	Hobbies such as painting, sculpting, welding, woodworking, piloting, auto maintenance and repair, ceramics, and gardening may bring chemicals into the home environment.
Safety issues	Seatbelt use, and home and recreational safety
Travel history	Obtain information on recent travel.

FIGURE 6-1 • Many jobs require work in confined spaces. (Photograph by Earl Dotter.)

major past occupations of patients and key information on residential and other environmental exposures. The extent of detail depends largely on the clinician's level of suspicion that occupational or environmental factors may have caused or contributed to the patient's illness. The history should always be recorded with great care and precision.

Some hospitals and clinics have standardized forms for occupational and environmental histories, which can expedite the taking and recording of this information and make gathering this information feasible for those providing comprehensive primary care. Ideally, such forms should include (a) a grid with column headings for job, employer, industry, major job tasks, dates of starting and stopping the job, and major work exposures (Fig. 6-3); and (b) a series of questions on environmental exposures. It may be helpful to ask questions from a list prepared in advance about whether the patient has had any exposures to hazardous substances or physical factors, such as noise or radiation. Further elaboration on each of the key parts of the occupational and environmental histories may be helpful, especially when (a) the patient raises concerns about potential exposures, (b) the clinician needs to further evaluate exposures of concern, (c) organ systems that are commonly associated with exposure are adversely affected, or (d) the diagnosis remains unclear.

FIGURE 6-2 • Workers eating in the workplace may ingest toxic substances. (Photograph by Earl Dotter.)

Sometimes there is an additive or synergistic relationship between occupational and environmental factors in causing disease. The clinician should ask whether the patient smokes cigarettes, is exposed to environmental tobacco smoke, or drinks alcohol; if so, amount and duration should be quantified. For skin problems, questions should be asked regarding recent exposure to new soaps, cosmetics, or clothes.

Other information that the clinician obtains may supplement the history. It is useful to know whether the patient has had preplacement or periodic physical and laboratory examinations at work. For example, preplacement audiograms or pulmonary function test results may be helpful in determining whether hearing impairment or respiratory symptoms are work–related. Because Occupational Safety Health Administration (OSHA) regulations mandate periodic screening of workers with certain exposures, such as asbestos or coke oven emissions, and because many employers voluntarily provide health screening in the workplace, it is increasingly likely that such information may be available to a clinician, if the worker approves its release.

Finally, it is often useful to ask the patient whether there is some reason to suspect that the symptoms may be related to external exposures.

When to Take Complete Occupational and Environmental Histories

In the following situations, the clinician should have a strong suspicion of occupational and environmental factors or influences on the development of the

1. Please provide the following information on your work history.

Job	Employer	Industry	Major job tasks	Dates of starting	Dates of stopping	Major work exposures*
CUSTODIAN	City of Boston	Day Care	Repair, cleaning	10/91	→	Flu, kid's infections; asbestos, cleaners
GRINDER	Hudson Engine	Engine Mfg.	Metal machining	10/86	10/91	Oil mist,
LATHE OPER.	Nash Engine	Engine Mfg.	Metal Machining	10/76	10/86	Noise
BORE MACHINE OPERATOR	Kaiser	Die Making	Cutting metals	10/70	10/76	Lifting/Twisting
VOLUNTARY FIREFIGHTER	Town of Salem	—	Fighting House Fires	10/68	10/79	Fumes, gases
STUDENT	—	—	Mechanic Student	6/68	9/70	Noise, oils
Military? YES	US Air Force	Helicopter Mech.	Motor Repair	1/67	1/68	Noise, Stress
Part-time work?	Town General Store	Retail Food	Checkout Clerk	1/64	1/67	Repetitive motion

2. Have you had any possibly hazardous exposures outside of work? Yes If yes, complete the following.

Major exposures	Associated activity	Location	Dates of starting	Dates of stopping
Wood dust	Cabinet making	Home	~1971	→

3. Have you ever smoked cigarettes? Yes If yes, please answer the following questions.
How old were you when you started smoking? 18
On average, how many packs have you smoked a day? 1/2
Do you currently smoke? No If no, how old were you when you stopped smoking? 31

*Such as chemicals, fumes, dusts, vapors, gases, noise, and radiation.

FIGURE 6-3 ● Sample occupational history form. (From Levy BS, Wegman DH. The occupational history in medical practice: what questions to ask and when to ask them. Postgrad Med 1986;79:301.)

problem and take detailed occupational and environmental histories. Many symptoms appear to be nonspecific but may have their origin in occupational and environmental exposures.

Respiratory Disease

Virtually any respiratory symptoms can be related to occupational and environmental factors. It is all too easy to diagnose acute respiratory symptoms as acute tracheobronchitis or viral infection when the actual diagnosis is occupational asthma or to attribute chronic respiratory symptoms as chronic obstructive pulmonary disease when the actual diagnosis is asbestosis. Viruses and cigarettes are too often assumed to be the sole agents responsible for respiratory disease. Adult-onset asthma is frequently work-related but often not recognized as such. In addition, patients with preexisting asthma may have exacerbations of their otherwise quiescent condition when exposed to workplace sensitizers. Less commonly, pulmonary edema can be caused by workplace chemicals such as phosgene or oxides of nitrogen; a detailed work history should be obtained for anyone with acute pulmonary edema when no likely nonoccupational cause can be identified (see Chapter 25).

Skin Disorders

Many skin disorders are nonspecific in nature, bothersome but not life-threatening, and self-limited. Diagnoses often are nonspecific, and physicians all too often fail to take a brief occupational and environmental history that might identify the offending irritant, sensitizer, or other factor. Contact dermatitis, which accounts for about 90 percent of all work-related cases and many other cases of skin disease, does not have a characteristic appearance. Determination of the cause depends on carefully obtained occupational and environmental histories (see Chapter 28).

Hearing Impairment

Many cases of hearing impairment are falsely attributed to aging (presbycusis). Millions of American workers have been exposed to hazardous noise at work, at home, at rock concerts, or elsewhere. For

this reason, detailed occupational and environmental histories should be obtained from anyone with hearing impairment. Recommendations for the prevention of future hearing loss should also be made (see Chapters 14A and 27).

Back and Joint Symptoms

Back pain is often partially work-related, but there are no tests or other procedures that can differentiate work-related from non–work-related back problems; its relationship to work depends on the occupational history. A surprising number of cases of arthritis and tenosynovitis are caused by rapid, forceful, awkward, and/or repetitive movements associated with work tasks. *Ergonomics*, the study of the complex interactions among workers, their workplace environments, job demands, and work methods, can help prevent some of these problems (see Chapters 11 and 23).

Cancer

A significant percentage of cancer cases are caused by occupational and environmental exposures, and, as time goes by, more occupational and environmental carcinogens are discovered. Often, the initial suspicion that a substance may be carcinogenic comes from individual clinicians' reports. This effort would be facilitated if occupational and environmental histories were obtained from all patients with cancer. Of importance in considering occupational and environmental cancer is that exposure to the carcinogen may have begun many years before diagnosis of the disease and that the exposure need not have been continued over the entire time interval (see Chapter 24).

Exacerbation of Coronary Artery Disease Symptoms

Exposure to stress (see Chapter 16) and to carbon monoxide and other chemicals in the workplace (see Chapter 13) may increase the frequency or severity of symptoms of coronary artery disease (see Chapter 30).

Liver Disease

As with respiratory disease, it is all too easy to give liver ailments common diagnoses such as viral hepatitis or alcoholic cirrhosis rather than the less common diagnosis of toxic hepatitis. It is always important to take a occupational and environmental histories from a patient with liver disease. Hepatotoxins encountered in the workplace and the general environment are discussed in Chapter 30.

Neuropsychiatric Problems

The possible relation of neuropsychiatric problems to occupational and environmental factors is often overlooked. Peripheral neuropathies are more frequently attributed to diabetes, alcohol abuse, or "unknown etiology"; CNS dysfunction to substance abuse or psychiatric problems; and behavioral abnormalities (which may be the first sign of work-related stress or, less frequently, a neurotoxic problem) to psychosis or personality disorder. More than 100 chemicals (including virtually all solvents) can cause CNS dysfunction, and several neurotoxins (including arsenic, lead, mercury, and methyl *n*-butyl ketone) can produce peripheral neuropathy. Carbon disulfide exposure can cause symptoms that mimic a psychosis (see Chapter 26).

Illnesses of Unknown Cause

Detailed, complete occupational and environmental histories are essential in all cases in which the cause of illness is unknown or uncertain (such as fever of unknown origin) or the diagnosis is obscure. The need to search carefully for an occupational and environmental source in such illnesses results from the increasing awareness of low-level environmental exposures as a cause of symptoms or disease. Such exposures may be related to hazardous wastes (see Chapter 20) or indoor air quality (see Chapter 18).

A key principle in toxicology and occupational and environmental health is that the biological response to a chemical or physical agent is primarily a function of dose. Although health effects from high levels of exposure typically are more frequent and more severe than those caused by low levels, more people are subject to low levels of exposure in the workplace and in the ambient environment. Health professionals who are approached by patients with symptoms they think are related to low levels of exposure to chemical substances should develop a caring and careful approach to addressing these concerns.

Symptoms associated with low-level exposures are often difficult to evaluate because of difficulty in documenting the exposure and because the symptom pattern is much less specific than that of a well-established disorder. Human variability is such that even a normal distribution of responses includes a few individuals who respond at very low doses. True allergic responses, unusual exposures, and new technologies may all present diagnostic challenges, and it is critically important that clinicians

not arrive at premature closure or fail to listen to their patients—a process that requires thoughtful evaluation of personal, home, and other life stressors. On the one hand, symptoms as obscure as difficulty in initiating urination have been caused by very specific neurotoxins introduced into the workplace. On the other hand, patients have had needless trauma and disability imposed on them through unnecessary testing and invasive procedures.

The history is still central in the final determination of how to care for these patients as indicated below, although laboratory investigation of the syndromes represented in these individuals may predominate.

1. If the problem is related to classic allergy, it may be possible to identify patterns of response of those who are severely atopic that explain the nonspecific stimuli associated with lower symptom severity between allergic attacks.
2. Some disorders may be associated with chemical or other environmental stimuli resulting in symptoms interpreted as being caused by the environment. A careful medical history should identify the need to have such patients evaluated by a specialist, especially because the relevant diagnoses may be ones of exclusion.
3. Building-related illnesses and multiple chemical sensitivity often present as diagnostic challenges (see Chapter 18).

SURVEILLANCE

Public health surveillance is the systematic and ongoing collection, analysis, and dissemination of information on disease, injury, or hazard for the prevention of morbidity and mortality. Surveillance as it applies to populations, also sometimes called public health tracking, should be differentiated from medical monitoring of individuals. *Medical monitoring*, sometimes refered to as *periodic medical screening*, is focused on the interview, examination, and/or testing of individuals. Public health surveillance is focused on populations. Although the overriding goal of medical monitoring and public health surveillance are the same (that is, prevention), the specific goals are different.

There are five goals of public health surveillance as it is applied to occupational and environmental disease:

1. *To identify illnesses, injuries, and hazards that represent new opportunities for prevention*: New opportunities can arise from new problems, such as might occur with the introduction of a new hazardous machine, from belated identification of a long-standing but ignored problem, or the recurrence of a problem previously controlled.
2. *To define the magnitude and distribution of the problem in the workplace and the general environment:* Information on magnitude and distribution is useful for planning intervention programs. Although no hazard is acceptable, the more common and severe problems deserve more immediate attention.
3. *To track trends*: Tracking trends of the magnitude of a problem is a rudimentary method of assessing the effectiveness (or lack of effectiveness) of prevention efforts. Epidemics can be tracked on their rise or their decline.
4. *To set priorities*: To identify categories of occupations, industries, and specific workplaces and environmental sites that require attention in the form of consultation, education, or inspection for compliance with established regulations.
5. *To publicly disseminate information*: This can facilitate appropriate personal and societal decisions.

There is a continuum of outcomes that could be monitored. The continuum may range from the presence of an exposure or hazard, to early and subclinical health effects of that hazard, to morbidity and associated medical care and disability, and finally to mortality (Fig. 6-4). The choice of an appropriate exposure or health outcome for surveillance should depend on the goal of the surveillance. Other considerations should include (a) an assessment of whether the proposed reporting entity, such as physician or employer, will report the occurrence; (b) the accuracy of the system in detecting real problems and minimizing false-positive leads; (c) the timeliness of the system in producing useful information; and (d) the cost of the system in relation to other systems that could be supported instead.

There are two approaches to surveillance: one based on cases and the other based on rates. *Case-based surveillance* relies on the intensive investigation of individual cases or clusters of cases. *Rate-based surveillance* is embedded in epidemiologic methods that determine the distribution or rate of disease, injury, or hazard in a population. Like communicable disease surveillance, which relies heavily on physician and laboratory reporting of cases

FIGURE 6-4 • The continuum of environmental and occupational health surveillance (Adapted from: Thacker SB, Stroup DF, Parrish RG, et al. Surveillance in environmental public health: issues, systems, and sources. American Journal of Public Health 1996;86:633–638.)

of disease, occupational and environmental health practitioners often rely on surveillance of sentinel health events, which may lead to their conducting intensive investigations of unusual cases of disease or disease clusters. *Sentinel health events* are defined as cases of disease, injuries, or exposures that represent failures of the system for prevention.[1] Some examples include the discovery of lead contamination in imported candy through the investigation of a cluster of cases of lead poisoning in children, and the identification of occupational asthma in workers using solvents to remove graffiti from public spaces.

Rate-based surveillance is embedded in epidemiologic methods that determine the rate of occurrence of disease, injury, or hazard in a population, track this rate over time, or compare it with rates in other populations. Surveillance differs from *epidemiologic research* in that it is an ongoing activity with goals directly related to the functioning of the public health system; in contrast, epidemiologic research assesses possible associations between exposures and adverse health effects. Epidemiologic research also involves intensive collection of data during a limited time period, rather than the ongoing collection and assessment of data that comprise surveillance. In reality, the distinctions between surveillance and research often blur.

Surveillance can be used to monitor the occurrence of disease at each point within the exposure–disease continuum (Fig. 6-4). *Hazard surveillance* is used to determine the distribution of agents that could potentially lead to disease. Examples of hazard surveillance include the number and geographic distribution within a community of homes that contain lead-based paint or the types and quantity of pesticides used in an agricultural area. *Exposure surveillance* is used to document the frequency and distribution of indicators that the host has been exposed to the hazard, and it has reached the host's target tissues. Examples of exposure surveillance include elevated blood lead levels and depressions of cholinesterase levels in workers or community members exposed to organophosphate pesticides. *Health-outcome surveillance* measures the frequency and distribution of disease resulting from such exposure. Examples include measurement of cases of cognitive impairment in lead-exposed workers or children and of neuropathy after pesticide exposure.

The development of well-defined occupational and environmental health indicators has been extremely useful in promoting rate-based surveillance, as it allows the direct comparison of rates across different populations. *Indicators* are defined as specific health outcomes or factors associated with a health outcome, such as exposure to a hazard or an intervention to prevent a hazardous exposure. Recently, public health practitioners have developed occupational and environmental health indicators. (Tables 6-3 and 6-4).

Examples of Occupational Health Surveillance Programs

Although hazard and exposure surveillance is preferable to health-outcome surveillance, as it ideally leads to interventions before disease has occurred, hazard and exposure surveillance is often difficult and expensive to implement. Therefore, many occupational health surveillance programs have focused on health outcomes, based on sources described below.

TABLE 6-3

Types and Examples of Occupational Health Indicators

Occupational injuries and illnesses (combined)
- Nonfatal occupational injuries or illnesses reported by employers
- Work-related hospitalizations

Acute and cumulative occupational injuries
- Fatal work-related injuries
- Work-related amputations with days away from work reported by employers
- Work-related amputations with reports filed with the workers' compensation system
- Hospitalizations from work-related burns
- Work-related musculoskeletal disorders with days away from work reported by employers
- Carpal tunnel syndrome cases filed with the workers' compensation system

Occupational illnesses
- Hospitalizations due to or with pneumoconiosis
- Deaths due to or with pneumoconiosis
- Acute work-related pesticide-associated illnesses or injuries reported to poison control centers
- New cases of mesothelioma

Occupational exposures
- Elevated blood lead levels in adults

Occupational hazards
- Percentages of workers employed in industries at high risk for occupational morbidity
- Percentages of workers employed in occupations at high risk for occupational morbidity
- Percentages of workers employed in both industries and occupations at high risk for occupational mortality

Intervention resources for occupational health
- Occupational safety and health professionals
- OSHA enforcement activities

Socioeconomic impact of occupational injuries and illnesses
- Workers' compensation awards

Source: Council of State and Territorial Epidemiologists. Occupational Health Indicators. A Guide for Tracking Occupational Health Conditions and their Determinants. Atlanta, GA: CSTE, 2004. Available at <www.cste.org>. Accessed July 29, 2005.

TABLE 6-4

Types and Examples of Environmental Health Indicators

Hazard indicators (potential for exposure to contaminants or hazardous conditions)
- Criteria pollutants in ambient air
- Hazardous or toxic substances released in ambient air
- Residence in nonattainment areas (for criteria air pollutants)
- Motor vehicle emissions
- Tobacco smoke in homes with children
- Residence in a flood plain
- Pesticide use and patterns of use
- Residual pesticide or toxic contaminants in foods
- Ultraviolet light
- Chemical spills
- Monitored contaminants in ambient and drinking water
- Point-source discharges into ambient water
- Contaminants in shellfish and sport and commercial fish

Exposure indicators (biomarkers of exposure)
- Blood lead level (in children)

Health effect indicators
- Carbon monoxide poisoning
- Deaths attributed to extremes in ambient temperature
- Lead-induced adverse health effects (in children)
- Noise-induced hearing loss (nonoccupational)
- Pesticide-related poisoning and illness
- Illness or condition with suspected or confirmed environmental contribution (a case or an unusual pattern)
- Melanoma
- Possible child poisoning (resulting in consultation or emergency department visit)
- Outbreaks attributed to fish and shellfish
- Outbreaks attributed to ambient or drinking water contaminants

Intervention indicators (programs or official policies addressing environmental hazards)
- Programs that address motor vehicle emissions
- Alternate fuel use in registered motor vehicles
- Availability of mass transit
- Policies that address indoor air hazards in schools
- Laws pertaining to smoke-free indoor air
- Indoor air inspections

(continued)

TABLE 6-4

Types and Examples of Environmental Health Indicators

Emergency preparedness, response, and mitigation training programs, plans, and protocols
Compliance with pesticide application standards (among pesticide workers)
Health-based activity restrictions in bodies of water
Implementation of sanitary surveys
Compliance with operation and maintenance standards for drinking water systems
Advisories to boil water

Source: National Center for Environmental Health. Environmental Public Health Indicators. Atlanta, GA: NCEH, 2005. Available at <www.cdc.gov/nceh/indicators/>. Accessed July 29, 2005.

Death Certificates

The National Occupational Mortality Surveillance (NOMS) system of the National Institute for Occupational Safety and Health (NIOSH) collects and codes mortality and occupational information from about 500,000 death certificates annually from 23 states in the United States. This allows analysis of differential mortality patterns among occupations and industries and comparison of the distributions of industries and occupations among diseases.

Employer Records

An annual survey of a large sample of employers is performed by the Bureau of Labor Statistics (BLS) of the U.S. Department of Labor. Using information from the required "OSHA 300" log of injuries and illnesses, these data provide broad estimates of work-related disease and injury. However, the survey is limited by the absence of specific criteria for determining the work-relatedness of disease, the limited sensitivity of the OSHA 300 log for detecting cases, and the assurance of confidentiality, which limits the usefulness of the survey for identifying cases or workplaces for in-depth follow-up investigations.

Workers' Compensation Records

Although readily available in most states, workers' compensation data are limited because they include only those who file (generally workers with the more severe injuries and illnesses), they exclude most cases of chronic work-related disease, and they are limited by adjudication procedures and diagnostic criteria that vary from state to state (see Chapter 4). However, these data have been very useful in identifying new problems, such as violence toward women workers, and in providing estimates of the magnitude of newly identified problems, such as disability from knee disease in carpet installers.

Cancer Registries

Hospital-based, regional, or statewide cancer incidence registers can be useful sources of surveillance data on cancer but often provide only limited, if any, information on occupation.

Physician Reporting

In locations such as Alberta (Canada), Great Britain, Germany, and some states in the United States, the law requires physicians to report all work-related diseases and injuries or certain specified ("scheduled") conditions. Where this is effectively enforced, the scheduled diseases can be tracked and epidemics identified early.

Laboratory-Based Reporting

A state-based national system, the Adult Blood Lead Epidemiology and Surveillance (ABLES), collects information from U.S. states that require laboratories to report cases of excessive lead levels. This information has proved useful in making national estimates of lead poisoning, tracking trends, identifying underserved occupations and industries, and targeting specific worksites with excessive cases. The limitations of laboratory-based reporting include the limited number of conditions for which laboratories can be involved; an irony is that those workers with the most inadequate resources for assistance are also the least likely to be monitored for lead.

Sentinel Event Approaches

Examples of sentinel event approaches exist in both Great Britain and the United States. In Great Britain, the SWORD (Surveillance of Work-related and Occupational Respiratory Disease) system was developed to identify new and conduct surveillance on known types of occupational respiratory disease, using reports from thoracic and occupational physicians.[2] Preliminary success has led to efforts to replicate the model for occupational dermatitis. In the United States, NIOSH is working with states to develop state-based systems for surveillance of occupational disease and injury. Very successful programs have been established, for example to track cases of pesticide poisoning and occupational respiratory diseases such as silicosis and asthma.

Examples of Environmental Health Surveillance Programs

In contrast to occupational health surveillance, environmental health surveillance has traditionally focused on measuring environmental hazards and exposures rather than health outcomes. A number of factors make the surveillance of environmental health outcomes especially challenging. First, in many instances it is difficult to link health outcomes to specific environmental exposures. This difficulty may result from (a) the long latencies between exposure and some diseases, such as cancer; or (b) many diseases, such as asthma, being caused by both environmental and nonenvironmental factors. Second, many records, such as medical records, may not contain the information needed to link a disease to environmental exposures, for a number of reasons including an inadequate environmental history. Third, there are not yet biomarkers for many important environmental exposures that might allow clinicians to more definitively establish the role of a presumed environmental exposure in causing the disease of a patient.

Exposure Databases of EPA

The Environmental Protection Agency (EPA) has programs that track the levels of air and water pollution in communities throughout the United States. For example, the National Water Quality Inventory collects information on the quality of water used for drinking, swimming, and fishing, which is reported every other year by states, territories, and other jurisdictions. EPA also has an extensive national system for collecting measurements of the levels of the six criteria air pollutants (sulfur dioxide, nitrogen dioxide, ozone, lead, carbon monoxide, and particulate matter). (See Chapter 17.) The Toxic Release Inventory collects information on chemical releases and waste management reported by major industrial facilities throughout the country. These and other exposures have been organized into a national database by Environmental Defense, a nongovernmental organization, allowing individual communities to obtain a "scorecard" on local pollution levels.

Childhood Blood Lead Surveillance

The measurement of environmental lead exposure is a major public health priority, especially in young children who are especially vulnerable to its central nervous system toxicity. Since the 1970s, the Centers for Disease Control and Prevention (CDC) has been collecting data on blood lead levels from a sample of the U.S. population aged 1 to 5 through the National Health and Nutrition Examination Survey (NHANES). In 1997, CDC established a national data system to aggregate data on elevated blood lead levels in children under age 6 from state-based laboratory reporting programs. Although the threshold blood lead level that must be reported is variable and established by each individual state, CDC, in conjunction with the states, has established a standardized set of data that are collected each time a child is tested.

The CDC National Report on Human Exposure to Environmental Chemicals

CDC performs an ongoing assessment of the exposure of U.S. population to environmental chemicals using biomonitoring from blood and urine specimens. This program's first report, released in 2001, included 27 substances; the second, released in 2003, was expanded to 116 chemicals; the third, released in 2005, was expanded to 148 chemicals. The program is scheduled to continued issuing new reports every 2 years. These data allow physicians, scientists, and public health practitioners to know the "background" concentrations of certain chemicals in the general U.S. population in order to determine whether a specific population may have experienced higher exposures. These data also allow public health practitioners to focus investigations and interventions in those communities or populations with the highest exposure levels.

The Environmental Public Health Tracking Network

In 2001, the Pew Environmental Health Commission, established by the Pew Charitable Trust, concluded that there was no integrated system for tracking environmental health in the United States. Based on this commission's recommendations, the National Center for Environmental Health (NCEH) at CDC, in conjunction with governmental and nongovernmental partners, established a new environmental public health network. Central to this initiative was the creation of the environmental health indicators list shown in Table 6-4. A network of state and city health departments and a number of academic centers of excellence were funded to develop programs for capacity building and infrastructure development based on the collection of data on these indicators.

With time, it is likely that improved surveillance of occupational and environmental disease will yield additional useful information. In evaluating occupational and environmental surveillance programs, it is most important to clearly understand the goals of the specific surveillance system and to recognize that not every system will meet every goal.

More information on surveillance of occupational and environmental disease and injury can be obtained from (a) NIOSH, NCEH and the Agency for Toxic Substances and Disease Registry (ATSDR)—all at CDC; (b) workers' compensation system agencies in most states; (c) the BLS of the U.S. Department of Labor in Washington, D.C.; (d) EPA; and (e) the environmental and occupational disease and injury epidemiologists within health or labor departments in most states.

SCREENING FOR DISEASE

Screening is the search for previously unrecognized diseases or physiologic conditions in individuals who could benefit in some way from the detection of the condition, such as by removal from exposure or through treatment. It may be part of an individual clinician's evaluation of a patient's health or part of a large-scale prevention program of an employer, union, or other organization for a group of individuals, but the goal is always to improve the health of the persons screened. Screening methods can include questionnaires seeking suggestive symptoms or exposures, examinations and laboratory tests, or other procedures. To be widely used, the methods should be simple, noninvasive, safe, rapid, and relatively inexpensive. Screening is one technique in a continuum for the prevention of occupational and environmental disease. Screening only presumptively identifies those individuals who are likely (and those who are unlikely) to have a particular disease. Further diagnostic tests are almost always necessary to confirm the diagnosis or assess the severity of the condition.

Although screening data may eventually lead to more effective primary prevention measures, the purpose of screening is the identification of conditions already in existence at a stage when their progression may be slowed, halted, or even reversed. Screening is therefore a secondary prevention measure. Primary prevention measures that reduce workers' exposure to occupational and environmental hazards are, in general, more likely to improve health and prevent disease (see Chapters 7, 9, 10, and 11).

The main goal of screening is early detection and treatment of disease. Clearly, screening data, in addition to their clinical use for the protection of the individual screened, may be analyzed epidemiologically for the protection of the population of people similarly exposed.[3]

The employees at a particular workplace are a logical target for screening for occupational disease because they have some risk factors in common (their workplace exposures) and a clear opportunity for prevention in common (reduction or elimination of those exposures). In addition, a workplace can provide excellent opportunities for screening for treatable nonoccupational diseases, such as hypertension. To be effective, screening programs for occupational disease must meet the following five criteria:

1. Screening must be selective, applying only the appropriate tests to the population at risk for development of a specific disease, given exposures, demographic features, and other factors. A "shotgun" approach, involving a battery of tests, such as a "chemistry profile," applied indiscriminately without regard to the diseases for which the population is at risk, is generally not effective. The natural history of the exposure–disease relationship should be considered in the application of screening tests. For example, screening of workers exposed to asbestos during the first few years after the start of exposure may lead to a false sense of security, because there has not been sufficient time for the disease process to become detectable on screening examination.
2. Identification of the disease in its latent stage, instead of after symptoms appear, must lead to treatment that may impede progression of the disease in a given patient or to measures that prevent additional cases (Fig. 6-5). The major justification for screening for a disease for which there is no therapy is to allow an opportunity to control exposure and prevent disease in others similarly exposed.
3. Adequate follow-up is critical, and further diagnostic tests and effective management of the disease must be available, accessible, and acceptable both to examiner and worker. Lack of follow-up is a frequent deficiency in screening programs for occupational disease. Workers who have been screened should receive test

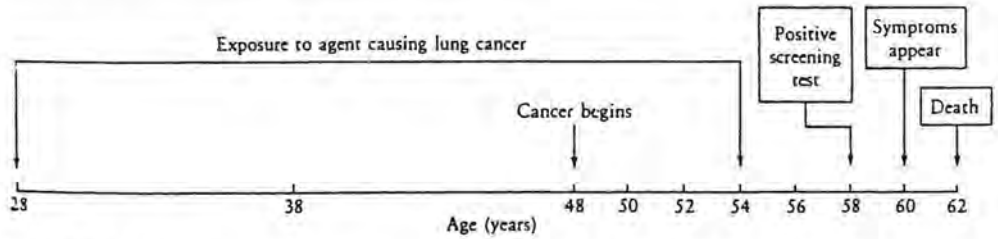


FIGURE 6-5 • Phases of cancer development. If the course of the disease cannot be positively influenced by early detection and effective treatment, there is no advantage to screening an individual for early detection of the disease.

reports along with interpretation of test results and, if possible, summary data for the entire group tested. (OSHA requires that records of medical monitoring be made available to affected employees. These records may be transmitted to third parties only with the written consent of the worker.) Follow-up also entails action to reduce or eliminate the hazard. An example is job transfer for the ill worker combined with improvements in the ventilation systems of the workplace; job transfer without action to control the underlying problem may result in exposure of another worker to the same hazard.

4. The screening test must have good reliability and validity. *Reliability* reflects the reproducibility of the test. *Validity* reflects the ability of the test to identify correctly which individuals have the disease and which do not. Validity is evaluated by examining sensitivity and specificity. *Sensitivity* is the proportion of those with the disease that the test identifies correctly; *specificity* is the proportion of those without the disease that the test identifies correctly. Another measure of a screening test is the *predictive value positive*, which is often more useful clinically than either sensitivity or specificity; it indicates the proportion of those with a positive screening test who actually have the disease (Table 6-5). The prevalence of the disease affects the predictive value positive. The predictive value positive rises as prevalence rises, even as the sensitivity and specificity of the test remain the same.
5. The benefits of the screening program should outweigh the costs. Benefits consist primarily of improved quality and/or length of life – that is, reduced morbidity and mortality. Costs include both economic costs (the expenses of performing the screening tests and further diagnostic tests and of managing the disease in affected workers) and human costs (the risks, inconvenience, discomfort, and anxiety of screening and of diagnostic workups for those with false-positive results). Screening tests in the community must be inexpensive because they compete with other public health resources, such as immunization. It should not be assumed that effective screening tests for occupational disease must be inexpensive, because they do not compete for the same resources, although the human costs to screening may be significant and should be carefully weighed in all settings. The cost–benefit equation is often difficult to determine and relies on tenuous assumptions, and workers and other patients may decline screening procedures based on their own risk–benefit assumptions. Strict financial analysis should not be allowed to obscure the primary objective of screening: early identification of work-related disease. Advocates of

TABLE 6-5

Hypothetical data: Screening of 100,000 workers for colon cancer[a]

	Colon Cancer Present		
Test Outcome	Yes	No	Total
Positive	150	300	450
Negative	50	99,500	99,550
Total	200	99,800	100,000

[a] These data assume the following:
Sensitivity = 150/200 = 75%. The test was (correctly) positive for 75% of actual cancer cases, but 25% of the actual cases were not detected.
Specificity = 99,500/99,800 = 99%. The test was (correctly) negative for 99% of those who actually did not have colon cancer.
Predictive value positive = 150/450 = 33%. Of those with a positive test, 33% actually had colon cancer.

screening should be cautious, because increased survival in those determined to have the disease by screening, compared with those detected after they become symptomatic, may be a result of lead-time bias or length bias. In *lead-time bias*, the apparently increased survival time results from adding part of the preclinical detection period to the postdiagnosis survival time and not from altering the actual duration of survival after the disease is contracted. In *length bias*, an apparently increased survival time results from the greater probability of detecting indolent, more benign disease than quickly developing disease, which is less likely to be detected because it is present for a shorter period.

Medical ethics demand that the patient encounter be conducted in the best interests of the patient (see Chapter 5). However, to the extent that screening programs are run for surveillance purposes or are otherwise required by public health or occupational health mandates, the interface between the clinician and the individual worker becomes more complex. These situations are fraught with potential ethical challenges that require care and thoughtful planning to address. There must be mutual trust among the individuals who have requested or authorized the screening program, the health professionals who are administering it, and the workers being screened. Without such trust, workers may be reluctant to be screened. This trust is developed, in part, by management personnel and health professionals assuring that screening data will be kept strictly confidential, will be used only for the stated purpose of the screening program, and will not adversely affect the worker's salary or other benefits. In addition, for any screening program to be effective, it cannot be used as a tool to discriminate—sexually, racially, or otherwise—against a specific group of workers.

Screening approaches for specific categories of work-related disease are covered in several chapters of Part IV of this book. The general industry

TABLE 6-6

Illustrative Components of Medical Monitoring in Selected OSHA Standards

Exposure	History	Physical Examination	Other Test/Procedures
Airborne asbestos	Especially respiratory symptoms	Especially chest examination	Chest x-ray, FVC*, and FEV_1*
Vinyl chloride	Especially alcohol use, history of hepatitis, transfusions	Especially liver, spleen, kidneys, respiratory system, skin, and connective tissue	Liver function tests
Inorganic arsenic	Especially respiratory symptoms	Especially nasal and skin examinations	Chest x-ray
Benzene	Including alcohol use and medications	If respirator used frequently, specific attention to cardiopulmonary exam	Complete blood count, including differential white cell count and red cell indices
Cadmium	Including respiratory, cardiovascular, and renal symptoms	Especially blood pressure, respiratory and genitourinary system	Urine cadmium, blood cadmium, β-2 microglobulin in urine
Methylene chloride	Including neurological symptoms and heart, liver, and blood disease	Particular attention to lungs, cardiovascular system, liver, skin, and neurological system	Based on medical and work history

*FVC = Forced vital capacity; FEV_1 = Forced expiratory volume in the first second.
Source: OSHA. Code of Federal Regulations (CFR) Title 29: General industry.

standards for specific hazardous exposures, published by OSHA, specify requirements for medical monitoring of exposed workers.[4] These may include preplacement and periodic screening histories, examinations, and tests. Table 6-6 illustrates some of the specific screening tests required by OSHA. OSHA also requires employers to keep records of this surveillance and to make these records available to affected employees. The records can also be made available to physicians or other third parties on specific written request.

In conclusion, as the theme of a conference on screening stated: "Screening and monitoring, in and of themselves, prevent nothing; only the appropriate intervention, in response to results of these tests, can prevent."[5]

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