4 Recognizing Occupational Disease and Injury

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To effectively prevent occupational disease and injury, health care providers must know how to recognize work-related conditions, not only in workers who present with symptoms but also in those who are presymptomatic and in those for whom individual and group health information is available. 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. *Primary prevention* is designed to deter or avoid the occurrence of disease or injury. *Secondary prevention* is designed to identify and adequately treat a disease or injury process as soon as possible. *Tertiary prevention* is designed to treat a disorder when it has advanced beyond its early stages so as 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 worker with an occupational illness or injury is essential to maximize opportunities for tertiary prevention and can also promote primary and secondary prevention. The selection and use of screening and monitoring tests that are appropriate to identify workplace risks promotes secondary prevention. A carefully designed occupational surveillance program, using both case- and rate-based approaches, promotes primary 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 workers who are ill or injured, (d) preventing recurrence of disease and injury of affected workers and occurrence of disease and injury in other workers who are exposed to similar risks, (e) ensuring that affected workers receive economic compensation legally due them, and (f) discovering new relationships between work exposures and disease.

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

DIAGNOSIS OF SYMPTOMATIC WORKERS

Proper diagnosis of illness or injury related to work requires information from a variety of sources. Successful identification of the work association rarely results from a single laboratory test or diagnostic procedure, but

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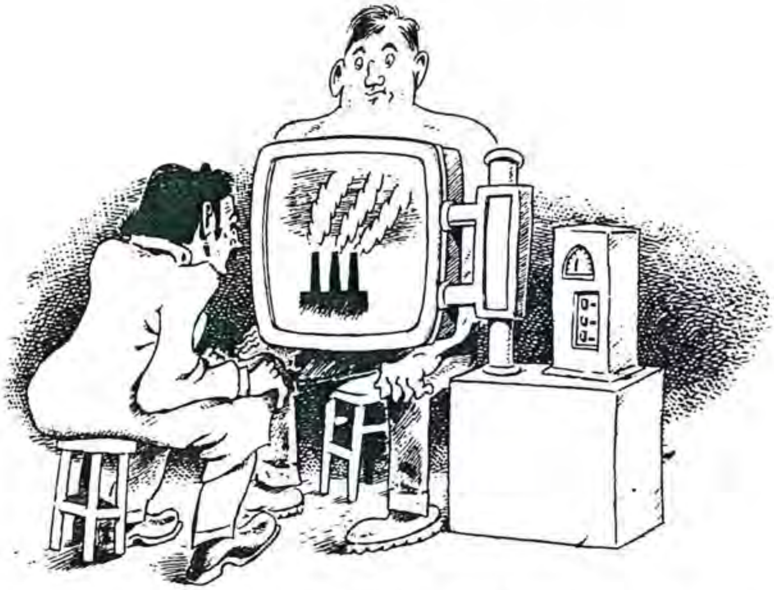


Physicians and other health professionals have a vital role in recognizing occupational disease. Contrary to the drawing above, there is no simple test. The suspicion and the determination of work-relatedness depend primarily on a careful occupational history. (Drawing by Nick Thorkelson.)

rather depends critically on a comprehensive and appropriate patient history that adequately explores the relation of the illness to the occupation.

The more specialized use of the laboratory for biomonitoring and clinical testing, the need for proper environmental exposure assessment, and the important concerns with ethical, legal, and socioeconomic factors are addressed in subsequent chapters. In this section, attention is devoted exclusively to the task of obtaining and interpreting the occupational history.

The Occupational History

Consider the following four cases:

1. A woman who worked in a high-tech manufacturing plant had numbness in her distal arms and legs that her physician attributed to her diabetes.
2. 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.
3. 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.
4. 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.

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 incorrect diagnosis because of a common oversight—failure to take an occupational history.

The first patient had a peripheral neuropathy and the second had acute central nervous system (CNS) intoxication, both caused by exposure to 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.

This is not to say that the associations noted by the physicians were unrelated to the conditions diagnosed. They were probably contributory in at least the first, third, and fourth cases, but without the occupational history, proper therapy and prevention could not be planned.

The identification of work-related medical problems depends most importantly on the occupational history. Physical examination findings and laboratory test results may sometimes raise suspicion or help confirm that a medical problem is work related, but ultimately it is information obtained from the occupational history that determines the likelihood that this is the case. A phrase or two in the psychosocial section of the medical history is not enough; the physician should obtain data on the current and the two major past occupations for all patients. The extent of detail depends largely on the physician's level of suspicion that work may have caused or contributed to the patient's illness. The history should be recorded with great care and precision so that the data may be used for legal or research purposes.

What Questions to Ask

The occupational history has five key parts (Box 4-1): (a) a description of all of the patient's pertinent jobs, both past and present; (b) a review of exposures faced by the patient in these jobs; (c) information on the timing of symptoms in relation to work; (d) data on similar problems among coworkers; and (e) information on nonwork factors, such as smoking and hobbies, that may cause or contribute to disease or injury.

Box 4-1. Outline of the Occupational History

1. Descriptions of all jobs held
2. Work exposures
3. Timing of symptoms
4. Epidemiology of symptoms or illness among other workers
5. Nonwork exposures and other factors

Some hospitals and clinics have standardized forms for recording the occupational history, which can expedite the taking and recording of this information. Ideally, such forms should include a grid with column headings for job, employer, industry, major job tasks, dates of starting and stopping the job, and major work exposures. It may be helpful to ask questions about whether the patient has had any exposures to hazardous substances or physical factors such as noise or radiation, from a list prepared in advance. On such an occupational history form (Fig. 4-1), the rows of the grid should be completed with information on each job, starting with the current or most recent job.

Further elaboration on each of the key parts of an occupational history may be helpful.

Descriptions of All Jobs Held

The history should include descriptions of all jobs held by the patient; in some cases, it may be important also to obtain information on summer and part-time jobs held while attending school. (Generally, details of these jobs are sought only on second interviews.) Job titles alone are not sufficient: An electrician may work in a plant where lead storage batteries are manufactured, a clerk may work in a pesticide-formulating company, or a physician may perform research with hepatitis B virus. It is important to remember that workers in heavy industry are not the only ones prone to occupational diseases—so are clerks, electronic equipment assembly work-

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	4/68	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.

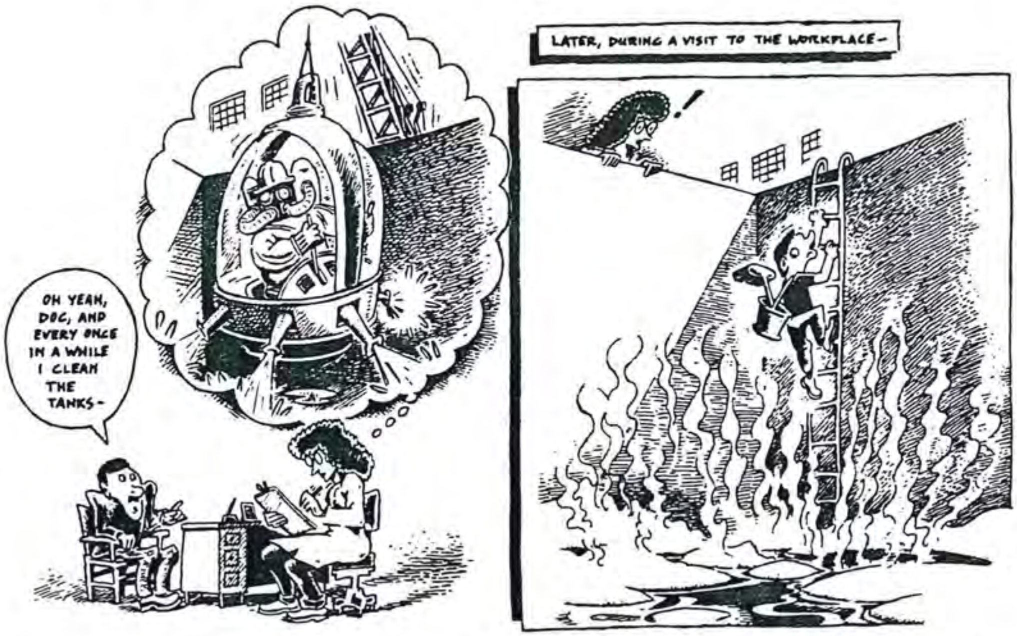
FIG. 4-1. Sample occupational history form. (From BS Levy, Wegman DH. The occupational history in medical practice: what questions to ask and when to ask them. Postgrad Med 1986;79:301.)

ers, domestic workers, food service employees, and virtually all other types of workers. To learn exactly what the patient does at work, it may be useful to have the patient describe a typical work shift from start to finish and simulate the performance of work tasks by demonstrating the body movements associated with them. A visit to the patient's workplace by the physician may be necessary and is always informative.

The history should describe routine tasks (unless the job title is self-explanatory); unusual and overtime tasks, such as cleaning out tanks, should also be noted, because they may be the most hazardous assignments in which a patient is involved. It is important to ask about second or part-time jobs, the patient's work in the home as a homemaker or parent, and service in the military.

Work Exposures

The patient should be questioned carefully about working conditions and past or present chemical, physical, biologic, and psychological exposures. As in other parts of a medical history, to avoid limiting the responses, open-ended questions are asked initially, "What have you worked with?". Then more specific questions are asked, such as, "Were you ever exposed to lead? Other heavy metals? Solvents? Asbestos? Dyes?" Some knowledge of the most likely exposures in the jobs listed can help focus additional questions, and it is important to remember that tasks performed in adjacent parts of the workplace can also contribute to a worker's exposures. It is often worthwhile to rephrase important questions and



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

sk them at two points in the interview, be-ause patients sometimes recall, on repeat uestioning, exposures that they initially verlooked. It is also wise to inquire about nusual accidents or incidents that may be elated to the patient's problem (such as pills of hazardous materials), work in con-ned spaces (Fig. 4-2), and new substances changed processes at work.

Many workplace chemicals and other sub-ances are referred to only by brand names, ang terms, or code numbers. It should be ossible for a physician to obtain a list of the gredients of most chemicals and to deter-ne the nature of any hazard (see Appendix). The federal Hazard Communication andard is also helpful (see Chapter 10). many states and localities, right-to-know ws facilitate the process whereby workers d their health care providers, with only ited information, can determine the toxic ects of these substances.

t is important to quantify these exposures accurately as possible. Clinicians can esti-

FIG. 4-2. Many jobs require work in confined spaces. (Photograph by Earl Dotter.)

mate the degree of exposure by determining the duration of exposure and route of entry. Large amounts of volatile substances such as solvents can be inhaled unknowingly, especially if they do not irritate the upper respiratory tract or do not have a strong odor. Large amounts of certain substances—again, solvents are a good example—can be absorbed through the skin without the worker's being aware of the degree of this exposure. The patient should be asked to describe the amount of a potentially hazardous material that contacts skin or clothes or is inhaled on a typical workday. The patient should also provide information on eating, drinking, and smoking in the workplace, because contamination of hands can lead to inadvertent ingestion of toxic materials (Fig. 4-3). Handwashing and showering at work, changing of workclothes, and who cleans the workclothes may also be relevant.

It should be determined whether personal protective equipment (PPE)—such as gloves, workclothes, masks, respirators, and hearing protectors—has been provided, and if, when, and how often the worker has used this equipment. If PPE is not being used, it is important to determine the reasons. Masks and respirators frequently are not worn because of poor fit, discomfort in hot weather, and difficulty in communicating when the mask is worn. In addition, masks and respirators that are not properly maintained are ineffective. If PPE is being used, it should be determined whether the equipment appears to fit and work properly. The presence of protective engineering systems and devices (e.g., ventilation systems) in the workplace and whether they seem to function adequately should be determined.

FIG. 4-3. Workers eating in the workplace may ingest toxic substances. (Photograph by Earl Dotter.)

Timing of Symptoms

Information on the time course of the patient's symptoms is often vital in determining whether a given disease or syndrome is work related. The following questions are often useful: "Do the symptoms begin shortly after the start of the workday? Do they disappear shortly after leaving work? Are they present during weekends or vacation periods? Are they time-related to certain processes, work tasks, or work exposures? Have you recently begun a new job, worked with a new process, or been exposed to a new chemical in the workplace?"

Questions on recent changes at work are often critical in suspecting or proving that a disease is work related. On the basis of the responses to these and related questions the physician can determine whether the period from the start of exposure to the onset of symptoms and the time course of the patient's symptoms are consistent with those of the suspected illness. For example, certain irritants with low water solubility produce severe pulmonary damage and even fatal pulmonary edema with onset about 12 to 18 hours after work ceases. Symptoms of byssinosis are characteristically worse on returning to work on Monday morning. Nitroglycerin workers, whose blood vessels have dilated because of work exposure to nitrates, may suffer "withdrawal" angina while away from work. Latent periods vary, and occupational causes should not be ruled out simply because the timing of symptoms does not initially correlate with time spent at work.

Epidemiology of Symptoms or Illness Among Other Workers

The patient's knowledge of other workers at the same workplace or in similar jobs elsewhere who have the same symptoms or illness may be the most important clue to recognizing work-related disease. The physician should inquire further what the affected workers share in common, such as similar job, exposure, physical location in the workplace, age, or gender. Queries should be made regarding birth defects among offspring, fertility problems, cancer incidence, and high turnover or early retirement for health reasons. Workers and then their physicians linked the pesticide dibromochloropropane (DBCP) to male sterility and the catalyst dimethylaminopropionitrile (DMAPN) to bladder neuropathy by recognizing that similarly exposed workers had the same medical problems. However, workers may not always be aware of symptoms present in coworkers.

Nonwork Exposures and Other Factors

Sometimes there is a synergistic relation between occupational and nonoccupational factors in causing disease. The clinician should ask whether the patient smokes cigarettes 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. The clinician should also ask whether the patient has any hobbies (e.g., woodworking, gardening) or other nonwork activities that involve potentially hazardous chemical, physical, biologic, or psychological exposures that may account for the symptoms; whether the patient lives near any factories, toxic waste sites, or contaminated sources of water; and whether the patient lives with someone who brings hazardous workplace substances home on workclothes, shoes, or hair. The same suggestions noted in the Work Exposures section apply here: repeated questioning, quantification of exposure to the degree possible, and obtaining generic names of substances. Questioning should be aimed at determining both current and past exposures.

Other information that the clinician obtains may supplement the occupational 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 and 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 physician, 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 work related.

When to Take a Complete Occupational History

A work history should always contain information on past and present jobs of the patient to provide a good understanding of how the workday is spent and what potential health hazards may exist. It is impossible to obtain a detailed occupational history on every patient seen, but every medical history should include at least the two major previous jobs and the current job.

In the following situations, the clinician should have a strong suspicion of occupational factors or influences on the development of the problem and take a detailed, complete occupational history. Many symptoms appear to be nonspecific but may have their origin in occupational exposures.

(Drawing by Nick Thorkelson.)

Respiratory Disease

Virtually any respiratory symptoms can be work related. 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 history that might identify the offending irritant, sensitizer, or other factor. Contact dermatitis, which accounts for about 90% of all work-related skin disease, does not have a characteristic appearance. Determination of the etiologic agent and work-relatedness depends on a carefully obtained work history (see Chapter 27).

Hearing Impairment

Many cases of hearing impairment are falsely attributed to aging (presbycusis) or other nonoccupational causes. Millions of American workers have been exposed to hazardous noise at work; for this reason, a detailed occupational history should be obtained from anyone with hearing impairment. Recommendations for the prevention of future hearing loss should also be made (see Chapter 1).

Back and Joint Symptoms

Most back pain is at least partially work related, but there are no tests or other procedures that can differentiate work-related from non–work-related back problems; the determination of likelihood depends on the occupational history. A surprising number of cases of arthritis and tenosynovitis are caused by unnatural 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 9 and 26).

Cancer

A significant percentage of cancer cases are caused by work exposures, and, as time goes by, more occupational carcinogens are discovered. Often the initial suspicion that a workplace substance may be carcinogenic comes from individual clinicians' reports. This effort would be facilitated if occupational histories were obtained from all patients with cancer. Of importance in considering occupational cancer is that exposure to the carcinogen may have begun 20 or more years before diagnosis of the disease and that the exposure need not have been continued over the entire time interval (see Chapter 16).

Exacerbation of Coronary Artery Disease Symptoms

Exposure to stress (see Chapter 21) and to carbon monoxide and other chemicals in the workplace (see Chapter 15) may increase the frequency or severity of symptoms of coronary artery disease (see Chapter 32).

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 diagnoses of work-related toxic problems. It is always important to take a good occupational history from a patient with liver disease. Hepatotoxins encountered in the workplace are discussed in Chapter 34.

Neuropsychiatric Problems

The possible relation of neuropsychiatric problems to the workplace is often overlooked. Peripheral neuropathies are more frequently attributed to diabetes, alcohol abuse, or "unknown etiology"; CNS depression, 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 depression, 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 Chapters 29 and 30).

Illnesses of Unknown Cause

A detailed, complete occupational history is 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 a work-related source in such illnesses results from the increasing awareness of low-level environmental exposures as a cause of symptoms or disease. Although this issue has been raised most forcefully by groups concerned about hazardous waste disposal sites and indoor air quality (see Chapter 23), medical authorities increasingly have found reason to look more closely at this complex topic.

A key principle in toxicology and occupational health is that the biologic response to a chemical or physical agent is primarily a function of exposure 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. It is important for health professionals who are approached by workers with symptoms they think are related to low levels of exposure to chemical substances to 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. Health professionals may be skeptical and may wish to dismiss such complaints or to direct these patients to other specialists. This attitude is supported when there is the impression that complaints are being driven by psychosocial aspects of the job or other non–health-related factors.

As the complex nature of human physiology and its response to toxic materials evolves, however, there are compelling reasons why such cases should be examined systematically before they are set aside. Indirect toxic responses (allergic responses) may well not have a clear threshold dose below which effects do not occur. Moreover, human variability is such that even a normal distribution of responses includes a few individuals who respond at the low dose extremes. In addition, increasing experience with confusing problems such as the sick building syndrome makes clear that some patterns of response are environmentally related despite the absence of readily identifiable causal factors.

Although laboratory investigation of the syndromes represented in these workers may predominate, the history is still central in the final determination of how to care for these patients as indicated below:

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 effectively explain the nonspecific stimuli associated with lower symptom severity between actual allergic attacks.
2. Anxiety 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. Sick building syndrome, a disorder caused by poor ventilation, is discussed further in Chapter 23. Characteristic symptoms of fatigue and respiratory, dermal, and CNS complaints are reported in association with a specific environment. Here the history should identify similar illnesses in coworkers and relate the symptoms to presence in a specific environment.
4. Attention has been drawn to a syndrome referred to as multiple chemical sensitivities (MCS) (1,2). This syndrome is reported to affect multiple systems and to occur in multiple, unrelated environments. Stimulants are reported to include such seemingly unrelated low-level chemical exposures as perfumes, petroleum derivatives, and smoke. Although there is often a willingness to attribute these symptoms to a primary anxiety disorder, few MCS cases meet the established criteria for this psychiatric diagnosis. Careful and well-documented medical and environmental histories may shed light on MCS as more knowledge develops.

In concluding this section on the diagnosis of symptomatic workers, it is surprising how current the following advice still is (3):

> If the recording intern would only treat the poison from which the man is suffering with as much interest as he gives to the coffee the patient has drunk and tobacco he has smoked, if he would ask as carefully about the length of time he was exposed to the

poison as about the age at which he had measles, the task of the searcher for the truth about industrial poisons would be made so very much easier.

SCREENING FOR OCCUPATIONAL DISEASE

Screening for occupational disease is the search for previously unrecognized diseases or physiologic conditions that are caused or influenced by work-associated factors. It may be part of an individual physician's evaluation of a patient's health or part of a large-scale prevention effort by an employer, union, or other organization. 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 disease. Other techniques include eliminating hazards from the workplace; containing hazards with engineering controls; protecting workers with PPE such as gloves and respirators; measuring intoxicants in the environment (environmental monitoring) or in biologic samples (biologic monitoring); and detecting, screening, and treating occupational diseases at early stages, when they are reversible or more easily treatable (4). As with screening for nonoccupational diseases, screening for work-related diseases 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 and assess the severity of the worker's 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 can be slowed, halted, or even reversed. Screening is therefore a secondary prevention measure. Primary prevention measures that reduce workers' exposure to occupational hazards are, in general, more likely to improve health and prevent disease (see Chapters 5, 7, 8, and 9).

The main goal of screening is early detection and treatment of disease; other goals include evaluation of the adequacy of exposure control and other means of primary prevention, detection of previously unrecognized health effects suspected on the basis of toxicologic and other studies, and suitable job placement. Clearly screening data, in addition to their clinical use for the protection of the individual screened, may be useful in a surveillance system in which they analyzed epidemiologically for the protection of the community of similarly exposed workers (5).

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 (e.g., "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.

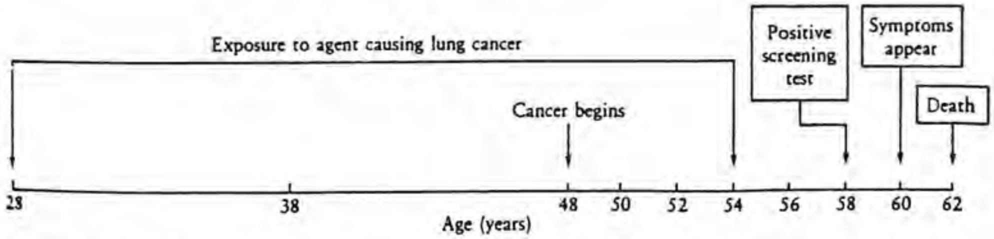


FIG. 4-4. Phases of cancer development. If the course of the disease cannot be positively influenced by early detection and effective treatment, there is no advantage to screening an individual for early detection of the disease. Current screening tests for lung cancer have yet to be proved effective. Screening may detect cancer earlier than would occur without screening, but the eventual time of death is not significantly changed.

2. Identification of the disease in its latent stage, instead of after symptoms appear, must lead to treatment that impedes progression of the disease in a given patient or to measures that prevent additional cases (Fig. 4-4). 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 reports along with interpretation of test results and summary data for the entire group tested. (OSHA requires that records of medical surveillance be made available to the affected employee. 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 plant; 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 4-1). The prevalence of the disease affects the predictive value. The pre-

TABLE 4-1. *Hypothetical data: Screening of 100,000 workers for colon cancer**

	Colon cancer present		
Test outcome	Yes	No	Total
Positive	150	300	450
Negative	50	99,500	99,550
Total	200	99,800	100,000

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.

dictive value rises as prevalence rises, even if 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 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. The cost-benefit equation is often difficult to determine and relies on tenuous assumptions. Such analysis should not be allowed to obscure the primary objective of screening: early identification of work-related disease. Advocates of 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.

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

The following paragraphs review current screening approaches to five major categories of work-related disease: nonmalignant respiratory disease, hearing impairment, toxic effects, cancer, and back problems. It may be noted that few of the current screening approaches for occupational disease meet all five criteria for effective screening.

Nonmalignant Respiratory Disease

Screening for acute work-related respiratory diseases such as irritant pneumonitis generally is not possible. Pathologic changes caused by exposure to irritant or toxic gases and fumes develop so quickly that there is no opportunity to screen for these disorders during a latent stage. However, many chronic work-related respiratory diseases are amenable to screening. The time from initial exposure to first appearance of symptoms in these diseases usually is very long—often years. Early identification of workers with asymptomatic pulmonary disease and reduction or elimination of their hazardous exposure may reverse the disease process or at least halt or slow its progression. Once well-established, however, most of these diseases are not reversible by currently available treatment, and they account for much morbidity and mortality (see Chapter 25).

Screening approaches for occupational respiratory diseases range from simple questions to sophisticated tests of pulmonary function. The four basic approaches are history of respiratory symptoms, physical examination, chest radiographs, and pulmonary function tests. Each has its strengths and weaknesses, and usually two or more approaches are used in combination.

History. By means of direct questioning or use of a standardized questionnaire,[1] information can be elicited on the presence of respiratory symptoms, including cough, sputum production, wheezing, and dyspnea. The worker is questioned about the presence of these symptoms, their time course, and their relation to airborne substance exposure, exertion, and work habits. The worker is also questioned about work history and in detail about cigarette smoking history. Although this approach is simple, inexpensive, without risk, usually acceptable to the worker, and capable of being performed by paramedical personnel or the worker, it has major weaknesses. With some diseases, such as asbestosis, cough, dyspnea on exertion, and other symptoms often do not appear until the disease is moderately advanced. The worker with lung disease may fail to report certain symptoms, such as "smoker's cough," that may be considered acceptable or unimportant. The worker may choose not to report certain symptoms for fear of losing a job or being labelled an unhealthy person. Finally, respiratory symptoms often result from causes other than chronic lung disease. (The first three of these weaknesses have to do with low sensitivity, the last with low specificity.)

Physical Examination. Performing a physical examination is generally a less helpful screening approach than obtaining a history of previously unrecognized respiratory symptoms. It, too, is simple, inexpensive, without risk, acceptable to the worker, and capable of being done by paramedical personnel; but it, too, has low sensitivity and specificity and is rarely helpful in screening for work-related pulmonary disease. For example, by the time basilar rales are heard in a person with asbestosis, significant fibrosis has already occurred, and such physical signs as clubbing and cyanosis usually are associated with far-advanced disease.

Chest Radiographs. Chest radiographs also have significant limitations in the early detection of chronic respiratory disease. This screening approach is more expensive and requires special equipment. In addition, with periodic radiographs a given worker may face some cumulative radiation hazard. Moreover, chest films usually are not very sensitive or very specific: the presence or absence of abnormalities does not always correlate with the intensity of symptoms, early physiologic abnormalities, or actual pathology. Chest films also fail to reveal early changes of chronic obstructive pulmonary disease, and they are subject to much variation in technique and interpretation. Despite these limitations, chest films can play an important role in the early diagnosis and assessment of work-related restrictive diseases, especially if chest radiographic abnormalities begin to appear relatively early in the course of chronic disease. (Chest radiographs are discussed again later in the context of lung cancer screening.)

Pulmonary Function Testing. Although it requires special equipment and therefore is more costly than performing histories or physical examinations, pulmonary function testing is a reasonably sensitive screening approach for work-related respiratory diseases, and it generally provides more useful screening information than the other approaches (Fig. 4-5). Pulmonary function tests used for screening are relatively easy to perform, and if they are properly done the results are reproducible.

Pulmonary function testing suffers from two general limitations: the range of normal is wide, and if the worker being tested does not cooperate fully artifacts can appear, es-

[1] An excellent questionnaire developed by the American Thoracic Society has been published (Ferris BG. Epidemiology standardization project. Am Rev Respir Dis 1978:118:7–54). It is also available from the National Heart, Lung and Blood Institute, Bethesda, MD 20892.

FIG. 4-5. Pulmonary function testing. (Photograph by Earl Dotter.)

pecially in tests requiring maximal effort. The first limitation can be countered by periodic testing of the same individual; test results in a given worker can be monitored over time and abnormalities can be identified when greater than expected decreases in function occur. The second limitation can be addressed by applying standardized rules for acceptable tests (see Chapter 25).

The two most frequently used screening tests for pulmonary function are forced vital capacity (FVC) and forced expiratory volume in the first second of expiration (FEV_1). FVC is the maximal volume of air that can be exhaled forcefully after maximal inspiration. For most people it closely approximates the vital capacity without a forced effort. FVC is reduced relatively early in restrictive diseases such as asbestosis. FEV_1 is the volume of air that can be forcefully expelled during the first second of expiration with a maximal effort after the lungs have been filled completely. It is reduced in both restrictive and obstructive disease but relatively more so than FVC in the latter. In the early course of asthma, it returns toward normal as the attack ends spontaneously or with the use of bronchodilators. Advances in assessing pulmonary dysfunction are occurring but generally require validation before they are ready for routine use (6). For further discussion, see Chapter 25.

Evaluation of Nonoccupational Risk Factors. Evaluation of workers for non–work-related risk factors that may predispose them to occupational pulmonary disease is another approach, albeit a controversial one. This is actually a method of primary prevention rather than screening. For example, some employers identify smokers, who may be at increased risk for a variety of occupational pulmonary diseases, and restrict them from certain jobs. This approach is sometimes opposed by workers who believe that it represents unfair discrimination. One large asbestos company has prohibited workers from smoking in the workplace—even at its corporate offices—and has refused to hire new workers who smoke. This approach is controversial also because it can encourage employers to avoid eliminating hazardous conditions and instead find workers with "iron constitutions" who can withstand these conditions. Decisions on this subject obviously involve both scientific assessments and public policy considerations of equity.

Screening for α_1-antitrypsin deficiency is an example of this approach to risk factor identification. People with a severe deficiency of this protein (1 in 5,000 of the general population) are at very high risk for development of emphysema and chronic bronchitis and should not work in a dusty workplace. It has not been established, however, whether those persons with lesser degrees of this deficiency are at increased risk for development of respiratory diseases.

Although there are many screening opportunities, occupational respiratory disease is difficult to detect before significant loss of lung function has occurred. Therefore, more reliance should be placed on methods of primary prevention, such as ventilation systems, changed work practices, and substitution of nonhazardous substances for hazardous ones.

Hearing Impairment

Several million Americans suffer chronic work-related hearing impairment, and several million American workers are exposed to loud noise at work that poses a threat to hearing (see Chapter 18). Even at the current OSHA standard of 90 dBA (decibels of sound pressure) for 8 hours of workplace noise exposure, it is estimated that 10% of those exposed for a lifetime will have significant hearing impairment. By the time a worker notices hearing impairment, irreversible sensorineural damage affecting the sound frequencies of human conversation has usually occurred. Long before a worker notices any hearing impairment, significant changes can be seen in the audiogram. Screening for hearing impairment is therefore important for workers exposed to loud noise.

The first sign of hearing impairment is a dip in the audiogram, usually at 3,000 to 6,000 Hz (cycles per second). If hearing impairment progresses, the audiologic abnormality becomes more severe and covers a broader range of frequencies. Discovery of an abnormal audiogram can indicate the need to prevent hearing impairment by reduction of noise at the source, modification of work procedures creating the noise, use of PPE (earmuffs or earplugs), or removal of the worker from a noisy work environment.

Audiograms should be performed as part of the preplacement examination of workers who will be exposed to loud noise at work, so that baseline findings will be available for comparison with later audiograms. They should be repeated for exposed workers every year. Audiograms should not be performed within 14 hours of any significant noise exposure; if they are preformed sooner, a temporary threshold shift may be mistakenly identified as a permanent one. As with other screening tests, it usually is best to compare test results repeated on an individual over time rather than with "normal limits." Because deterioration of hearing caused by loud noise exposure is fairly rapid for the first years of exposure, the effectiveness of a screening program is maximal during this initial work period.

Audiometry is generally accepted as a useful screening approach and is widely performed in industry in the United States. However, its value can be undermined by poor technique, such as inadequate calibration of equipment, excess noise in the testing room, headphone position variations, headset pressure against the external ear, examiner and tester biases, improved performance of the subject after familiarization with the testing procedure, obstruction of the ear canal, tinnitus, simulation or malingering, and fluctuation of the subject's criterion for threshold identification of the test tone. A study performed by the National Institute of Occupational Safety and Health (NIOSH) indicated that 80% of industries surveyed used inadequate audiometric equipment. However, most of these problems can be minimized with appropriately trained technicians and adequate equipment.

Toxic Effects

Three components are involved in the prevention of the toxic effects of workplace chemicals: evaluating the toxicity of the chemical itself (preferably before it is introduced, as the Toxic Substances Control Act now mandates) by means of animal studies and short-term *in vitro* assays; environmental monitoring of levels of the chemical in workplace air to determine whether it is controlled in accordance with recommended or mandated standards; and biologic monitoring (see also Chapter 15).

Biologic monitoring is the testing of blood, urine, or exhaled air of workers to determine either (a) the body's level of a hazardous chemical and its metabolites, or (b) reasonably specific biochemical changes that are associated with cellular damage. The first of these findings actually provides evidence of exposure; the second is considered screening in the strict sense. For the latter approach to be effective, it must detect early ("sentinel") biologic effects before serious health effects occur. As with other evaluation approaches, once biologic monitoring of any kind indicates that workers have excessive exposure or early toxic effects, measures must be taken to reduce their exposure to the responsible agents. Following are three examples of biologic screening:

1. Several volatile organic compounds, including benzene and toluene, if inhaled or absorbed through the skin, produce metabolites that can be measured in urine.
2. Organophosphate pesticides, before exerting any known health effects, begin to inhibit both plasma and red blood cell cholinesterase. The amount of plasma cholinesterase (pseudocholinesterase) reflects absorption of the organophosphate, and the activity of the red cell cholinesterase correlates well with the degree of adverse effect.
3. Various tests have been used to evaluate lead exposure or body burden and the biologic effects of lead. Biologic monitoring for lead is particularly useful because the early effects of lead poisoning may be reversible and because symptoms are nonspecific (such as headache or fatigue) or may be absent (see Chapters 15, 29, 31, and 35).

Biologic monitoring has a different use from environmental monitoring because it takes into consideration host differences in, for example, susceptibility to toxic effects and absorption, distribution, and biotransformation of the substance. It also considers possible multiple exposures (both occupational and nonoccupational) and multiple routes of absorption. A crucial issue is the relation between environmental monitoring and biologic monitoring. Because environmental monitoring leads to control of exposure before the absorption of the hazardous chemical, it is preferable. However, biologic monitoring should not be considered a substitute for environmental monitoring. Given the potential for multiple routes of exposure not well assessed by environmental monitoring (such as percutaneous absorption), biologic monitoring should be used as a valuable adjunctive, fail-safe technique.

Biologic monitoring is still in its infancy and has several limitations. For many substances, there is no known health effect parameter; as each new parameter is developed, its relation to both the amount of exposure and the disease must be established. The biologic half-lives of many toxins are not known, and screening may be done at the wrong time to identify acute intoxication or transient effects. For many known biologic parameters, the range of normal is wide, so it is necessary to base the interpretation of testing on a series of tests on the same individual over time. This demonstrates the importance of performing baseline biologic screening studies that are specific to known or anticipated hazards during the preplacement examination. Quality control in laboratories varies; it is essential that the laboratories performing the biologic monitoring ensure accurate results.

These potential problems make it crucial to plan biologic monitoring carefully. Workers who may be exposed must be identified. The appropriate parameter to monitor them must be chosen. Baseline measurements made before exposure and measurements made after exposure must be appropriately timed. There is also much room for error in the choice of specimen, the storage and handling of specimens, and the interpretation of results. However, biologic monitoring holds much promise, and with the increase of toxic substances in the workplace and greater recognition of toxic hazards, it can play an important preventive role.

There is no central repository of information for choosing biologic monitoring tests or appropriate laboratory methodology. NIOSH has developed a chart that provides a summary of the recommendations that have been made by a variety of experts for biomonitoring for industrial chemicals. It can be accessed via the World Wide Web at http://www.cdc.gov/niosh/nmed/medstart.html.

The World Wide Web is also a valuable source of policy papers on screening and monitoring and of summaries of recommendations that are being made in this evolving area. For example, see Guidelines for Health Surveillance from the Australian National Occupational Health and Safety Commission, which can be accessed at http://www.worksafe.gov.au/worksafe/fulltext/toc/01997- 01.htm.

Cancer

Screening has a limited role in occupational cancer control. National Cancer Institute data support the concept that early detection of cancer followed by appropriate treatment can increase survival time in some patients with certain cancers. Approaches that have been used to screen for different cancers include examination of exfoliated cells by the Papanicolaou technique (Pap smear); radiographs; proctosigmoidoscopy; identification of a substance in the blood or other body fluid that may be a specific marker for a given malignancy; breast self-examination; measures of organ function; and tests to detect colon cancer by identifying occult blood in the stool. These approaches have widely varying degrees of effectiveness (see Chapter 16).

Few screening approaches of any kind, however, have been proved to reduce mortality from cancer. As with screening for most chronic diseases, discussion of the effectiveness of cancer screening has been greatly confused by studies that do not differentiate between true mortality reduction and mere earlier identification.

A dramatic increase in the lung cance mortality rate has taken place in the past 5 years. Attempts to detect lung cancer earl have focused on periodic chest radiograph and cytologic examinations of sputum, whic tend to complement one another: chest ra diographs are more useful for detecting pe ripherally situated cancers, whereas sputur cytology can identify early squamous cell car cinoma involving major airways. Relativel few cases of lung cancer give a positive resul on both tests at the same time. Althoug these tests are often used to screen for lun cancer, neither has convincingly been show to be effective. Usually, by the time eithe of these tests presumptively identifies a lun cancer, it has metastasized and is incurable Well-controlled studies have demonstrate that the addition of sputum cytology to ches radiographic screening does not significantl reduce the mortality rate from all types o lung cancer but have suggested that mortality from squamous cell carcinoma is reduced (7) A report of three randomized trials o screening for early lung cancer indicated tha sputum cytology detects 15% to 20% of al lung cancers, mostly squamous cell carcinoma, with a relatively good prognosis, and that chest radiography alone may be a more effective test for early-stage lung cancer than previous reports suggested. However, a randomized clinical trial at the Mayo Clinic showed that performance of both procedures every 4 months resulted in no survival advantage compared with standard medical practices (8). Recent reports raise the possibility that CT scans may have a role in early detection of lung cancer.

The status of attempts to screen for bladder cancer is much the same as for lung cancer. The approaches used most frequently are a search for occult blood and cytologic examination of exfoliated cells in urine. These approaches successfully identified asymptomatic persons with early bladder cancer in a population at high risk because of exposure to aromatic amines (9). However, whether screening in this or similar high-risk groups leads to prolongation of life or decreased morbidity has not been evaluated in a controlled clinical trial. Given the continued high incidence of cancer (and the substantial incidence of occupational cancer), its severity, and the frequent lack of effective treatment, attempts will no doubt continue to develop better screening tests. In the meantime, health professionals should not raise false hopes of workers by using screening tests of unproven effectiveness and should concentrate on measures of primary prevention. These measures include testing workplace substances for carcinogenicity, limiting exposure to proven or suspected carcinogens, and encouraging smoking cessation, since smoking is associated with lung, bladder, and other cancers.

Back Problems

When the term "screening" is used to refer to back problems in the workplace, it usually refers to preplacement identification of preexisting back problems, both work-related and non–work-related, or of a predilection for back problems. Three methods have traditionally been used to try to identify workers at high risk for work-related back problems: history, physical examination, and radiographs of the lumbosacral spine. None of these methods has been effective in controlling low back injuries. Radiographs were used on the basis of a hypothesis, now shown to be false, that developmental abnormalities of the spine predispose to low back injury. The persistent use of back radiographs to detect such abnormalities not only is without benefit but also discriminates unnecessarily against prospective workers with radiographic abnormalities. Radiographs do not necessarily predict future back injury risk, and they create unnecessary exposure to x-rays. Although the only effective control for back problems today seems to be the ergonomic approach of designing the job to fit the worker, some evidence indicates that measurements of strength and fitness before the start of work can predict back injuries (see Chapters 9 and 26). In addition, strength measurements can be used to match a worker's strength to job requirements.

Possibilities for Improved Screening

Opportunities for effective screening for occupational diseases at present are relatively limited, and most available screening approaches do not meet the criteria outlined earlier in this chapter. Unless screening approaches are improved, much time, effort, and limited resources may be wasted; workers may face unnecessary risks and experience unnecessary anxiety and inconvenience; and workers and employers may become disillusioned with preventive approaches in general.

The general industry standards for specific hazardous exposures, published by OSHA, specify requirements for medical surveillance of exposed workers (10). These may include preplacement and periodic screening histories, examinations, and tests. Table 4-2 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.

Suggested principles for screening and biologic monitoring of the effects of exposure in the workplace and many related articles were the subject of an intensive national conference held in 1984 and published as the August and October 1986 issues of the *Journal of Occupational Medicine.* A central theme expressed in these discussions was the following: "Screening and monitoring, in and of themselves, prevent nothing; only the appropriate intervention, in response to results of these tests, can prevent" (11).

OCCUPATIONAL SURVEILLANCE FOR DISEASE CONTROL

Occupational surveillance is the systematic and ongoing collection, analysis, and dissemination of information on disease, injury, or

TABLE 4-2. *Illustrative components of medical surveillance in selected OSHA standards*

Exposure	History	Physical examination	Other tests/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, and kidneys	Liver function tests
Inorganic arsenic	Especially respiratory symptoms	Especially nasal and skin examinations	Chest x-ray Sputum cytology
Benzene	Including alcohol use and medications	If respirator used >30 days a year, specific attention to cardiopulmonary exam	Complete blood count Reticulocyte count Serum bilirubin
Cadmium	Including respiratory and renal symptoms, and medications	Especially blood pressure, respiratory and genitourinary system	Urinalysis Blood cadmium
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

Source: Occupational Safety and Health Administration, U.S. Department of Labor. Code of Federal Regulations (CFR) Title 29: General industry.

hazard for the prevention of morbidity and mortality. Surveillance as it applies to populations should be differentiated from *medical surveillance* of individuals. Medical surveillance, also known as "medical monitoring" and sometimes as "periodic medical screening," is focused on the interview and examination of the individual. *Public health surveillance,* of which occupational surveillance is a subset, is focused on populations. Although the overriding goals of medical surveillance 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 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, or 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 workforce. 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 in the magnitude of the problem as 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 target (identify) categories of occupations, industries, and specific worksites that require attention in the form of consultation, educational efforts, or inspection for compliance with established regulations.
5. To publicly disseminate information so that wise personal and societal decisions can be made.

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. The choice of an appropriate exposure or health outcome for surveillance should depend on the goal of the surveillance. Other considerations should include an assessment of whether the proposed reporting entity (such as physician or employer) will report the occurrence; the accuracy of the system in detecting real problems and minimizing false-positive leads; the timeliness of the system in producing useful information; and the cost of the system in relation to other systems that could be supported instead.

There are two kinds of surveillance. One is based on the intensive investigation of cases (*case-based*); the other is more embedded in epidemiologic methods, especially determination of the distribution or rate of disease, injury, or hazard in the population (*rate-based*). An underlying philosophy for case-based surveillance has been called the *sentinel health event (occupational) method,* or SHE(O) (12). A SHE(O) is defined as a case of disease, injury, or exposure that represents a failure of the system for prevention. Although a list of SHE(O)s has been published, this should not inhibit focusing on other adverse entities that are more germane to a local situation.

Rate-based surveillance is embedded in epidemiology in that it seeks to establish the rate of occurrence of the disease, injury, or exposure and to track that rate over time or compare it with the rate in some other population. Surveillance differs from epidemiologic research, however, in that surveillance is an ongoing activity with goals directly related to the functioning of the public health system, whereas epidemiologic research is concerned with assessing the association between effect and etiologic agent. Epidemiologic research also involves intensive collection of data during a limited period, rather than the ongoing collection and assessment of data that is part of surveillance. Although it is valuable to discern the differences between surveillance and research in their pure forms, in reality these distinctions often blur.

Surveillance can be used to monitor either the occurrence of diseases (or physiologic abnormalities) or the presence of hazardous substances and worker exposures to them. This section focuses on the use of surveillance in monitoring the occurrence of injury and disease. For chronic diseases caused by workplace exposures, monitoring of exposures may be more useful. This possibility exists because a number of exposure-effect relationships are now sufficiently well described so that the long-term exposures that predictably result in chronic illness are known. Furthermore, the long latency period between exposure and onset of chronic work-related disease makes it difficult to associate the exposure with the disease in an individual case. For diseases of shorter latency, direct disease surveillance may be useful.

In contrast to communicable disease surveillance, which is largely based on physician reporting, there are a variety of models for occupational disease surveillance. Some of these are broadly based, and others can be done on a workplace-specific or job-specific basis.

Broad-Based Occupational Surveillance Programs

Death Certificates. The National Occupational Mortality System (NOMS) of 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. It is one of the few systems capable of providing information about women and minority workers in the workforce. NIOSH also conducts surveillance for fatalities from injuries through the National Traumatic Occupational Fatalities (NTOF) system, which collects from all states death certificates in which the cause of death was an injury at work.

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 200" 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 200 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 11). 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. In Ohio, workers' compensation readily identified companies with excess cases of dermatitis, as well as the offending agent (13).

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 the 26 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 system was developed to identify new and survey known types of occupational respiratory disease, using reports from thoracic and occupational physicians (14). Preliminary success has led to efforts to replicate the model for occupational dermatitis. In the United States, NIOSH is working with 36 states to develop state-based systems for surveillance of occupational disease and injury. A central element of this effort is the Sentinel Event Notification System for Occupational Risks (SENSOR), which has included silicosis, occupational asthma, amputations, cadmium poisoning, carpal tunnel syndrome, child-labor injuries and illnesses, noise-induced hearing loss, pesticide poisoning, spinal cord injuries, and tuberculosis (15). New conditions are also being explored for inclusion in SENSOR. For example, states are now using workers' compensation reports and networks of dermatologists to report occupational dermatitis, and states are testing surveillance of severe occupational burns, using reports from hospital burn units.

Focused Occupational Surveillance Programs

Surveys of Workers. Interviews and examinations of workers represent an effective surveillance approach, especially for estimating the magnitude and distribution of occupational problems in the workforce. In addition to focused efforts at specific work locations, large interview surveys addressing the prevalence of cumulative trauma disorders, dermatitis, and other conditions have been conducted by the National Center for Health Statistics (NCHS). NCHS conducts other large examination surveys that contain limited information relevant to occupation, such as blood lead level.

Union Records. Unions may have morbidity or mortality data, often related to medical or death-benefit programs, that can be used for surveillance. Even without this information, union records can define the exposed, or at-risk, population, information needed in the search for adverse health outcomes in state vital registry records or cancer registries.

Employer Records. Employer records can be helpful for finding morbidity data, although such data are likely to underestimate the actual incidence of disease; such records may also provide valuable information on exposure.

Disability Records. Disability records can be examined as a potentially useful source of surveillance data (see Chapter 12).

Conclusion

With time, it is likely that improved surveillance of occupational disease will yield additional useful information. In evaluating occupational 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 disease and injury can be obtained from (a) NIOSH (see Appendix B); (b) workers' compensation system agencies in most states; (c) the BLS of the U.S. Department of Labor in Washington, DC; and (d) the occupational disease and injury epidemiologists within health or labor departments in most states.

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Occupational Health: Recognizing and Preventing Work-Related Disease and Injury, 4th ed.
Edited by Barry S. Levy and David H. Wegman. Lippincott Williams & Wilkins, Philadelphia © 2000.

Occupational Health

Recognizing and Preventing Work-Related Disease and Injury

Fourth Edition

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LIPPINCOTT WILLIAMS & WILKINS
A **Wolters Kluwer** Company
Philadelphia • Baltimore • New York • London
Buenos Aires • Hong Kong • Sydney • Tokyo

Acquisitions Editor: Joyce-Rachel John
Developmental Editor: Sonya L. Seigafuse
Production Editor: Steven Martin
Manufacturing Manager: Tim Reynolds
Cover Designer: Mark Lerner
Compositor: Bi-Comp
Printer: Maple Press

227 East Washington Square
Philadelphia, PA 19106-3780 USA
LWW.com

Printed in the USA

Library of Congress Cataloging-in-Publication Data

Occupational health : recognizing and preventing work-related disease and injury / edited by Barry S. Levy, David H. Wegman. — 4th ed.
p. cm.
Includes bibliographical references and index.
ISBN 0-7817-1954-2 (pbk.)
1. Medicine, Industrial. I. Levy, Barry S. II. Wegman, David H.
[DNLM: 1. Occupational Diseases—prevention & control. 2. Occupational Health. WA 440 0149 2000]
RC963.022 2000
616.9'803—dc21
DNLM/DLC
for Library of Congress 99-35194
CIP

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