Section One

Principles and Practice

Chapter 1

Principles and Practice of Occupational and Environmental Medicine

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Occupational and environmental medicine (OEM) is an emerging clinical specialty that seeks to identify and modify the adverse effects of the workplace and nonoccupational environment on the health of individuals or populations. The focus of OEM differs from that of many specialties, which may encompass interest in particular agents (e.g., infectious disease), organ systems (e.g., pulmonary medicine), or mechanisms of injury (e.g., immunology). In traditional clinical evaluation and treatment, the focus of attention is on factors that the patient or clinician, or both, can modify. In OEM practice, although the individual patient is also of primary importance, there is a need to attend to external factors that are distinctly beyond the direct control of patient or physician. Further, these same external factors affecting one patient may threaten the health of others. There is commonly a natural tension between the clinical health issues relating to the individual patient and broader public health issues, which transcend the traditional doctor-patient relationship.

Another dimension that distinguishes OEM practice is the extent to which social and economic factors dominate both clinical practice and related public health concerns. At the individual level, virtually no question about environmental or occupational health can be raised or answered without consideration of the impact on major personal issues, including the patient's work, income, or home life. Similarly, public health actions related to the identification of a toxic exposure at a workplace or in a community are complicated by economic and legal ramifications.

In this chapter, some of the core principles of OEM practice are explored that distinguish it from those aspects of clinical medicine with which the reader may be familiar. We will discuss the fundamentals of both individual health and related public health aspects of practice.

Patients, physicians, and third parties raise the issue of an environmental health concern or seek diagnostic consultation with a specialist for one of three reasons: (1) the patient (or referring party) suspects that symptoms, signs, or laboratory abnormalities may be due to some environmental or other occupational factor, (2) the cause of a disease may not be evident and a question arises as to whether it may be due to an environmental or occupational factor, and (3) although disease may not yet be evident, exposure to a suspected harmful agent has raised concern that early disease may be present or that the patient may be at risk for its occurrence.

Successful resolution of the problem requires sound understanding of the principles of occupational and environmental disease, detailed knowledge of the patient's current health status and exposure background, access to a database that can be applied to the patient's situation, and tools for applying scientific data to individual cases. In the sections that follow, these four central areas that form the core of OEM practice are reviewed.

PRINCIPLES OF OCCUPATIONAL AND ENVIRONMENTAL DISEASE

1. The clinical and pathologic expression of most environmentally caused diseases are indistinguishable from those of nonenvironmental origin.

There is a widely held belief among medical practitioners that diseases of occupational or environmental origin are both rare and distinctive. In reality, diseases of work and the environment are neither rare nor often distinctive in their clinical presentations and laboratory findings. Most occupational diseases, such as occupational cancers, not only resemble diseases caused by other factors but are otherwise indistinguishable except by careful documentation of a history of a relevant exposure. Other occupational and environmental diseases, like asthma or dermatitis, may be distinguished

clinically only through obtaining an exposure history, with or without specialized testing, which presupposes high suspicion for the diagnosis. Only the minority of occupational diseases, such as heavy metal poisonings, are sufficiently distinctive that they are likely to be identified by routine laboratory testing procedures.

2. Many diseases of occupational or environmental cause are multifactorial, with nonenvironmental factors playing a role.

The majority of chronic diseases and even a fair number of acute ones are multifactorial in origin. Coronary artery disease is, for example, not attributed to hypertension alone in a patient who also smokes. In fact, the discovery of one cause does not preclude the possibility of a second cause; it often makes the effect of an environmental exposure more likely. It has been well established that asbestos-exposed workers who smoke have a far higher likelihood of lung cancer than both nonsmokers and individuals exposed to cigarettes or asbestos alone. Similarly, alcohol consumption is known to potentiate the effects of some environmental hepatotoxins by causing hepatocellular disease.

The important aspect of this principle is that the potential role of an environmental toxin is not necessarily reduced by the presence of another pathogenic factor; in fact, it may be increased. This holds true for common types of clinical complaints that result from exposure to the environment, such as irritation and sensitization of the skin and respiratory tract. These problems are too often ascribed to causes such as smoking or viral infection, leaving remediable occupational and environmental causes undetected.

3. The effects of occupational and environmental exposures occur after a biologically predictable latent interval following exposure.

Agents or chemicals capable of causing direct and acute injury to the body will typically exert their effects either immediately or soon after exposure. In these cases, because the onset of disease occurs early, possible causal connections are relatively easily identified. On the other hand, the effects of agents that act by sensitizing the immune system, such as those that cause dermatitis or asthma, more often are exhibited only after a period of months to years of exposure.

Other substances initiate insidious disease processes that may become clinically apparent only after a latent interval of many years. For example, carcinogens may not cause cancer until years after the individual's first exposure. Importantly, there is no uniform relation between these late outcomes and any early effects. For example, leukemia may occur in a person exposed to external ionizing radiation at levels far below that which would cause acute radiation sickness or other demonstrable health effect. Indeed, individuals unaffected from early effects are sometimes at the highest risk for later effects because they tolerate doses of higher intensity and duration than those who suffer acute effects.

4. The dose of an exposure to a noxious agent is a strong predictor of the likelihood and type of effect.

Although this principle is elucidated in detail in Chapter 8, it is important to recognize that toxins, like drugs, have clear relationships between dose of exposure and subsequent effect, and proportion of exposed individuals affected. Although each host differs from others, knowledge of these relationships and estimation of the amount of an exposure is the key to diagnostic decision making.

In general, higher exposures confer a higher likelihood of being affected (dose-response relationship) and of more serious effects (dose-effect relationship). As shown in Figure 1, three distinct patterns can be discerned. For direct-acting toxins, such as heavy metals, organic solvents, or pesticides (Figure 1A), there is for each individual a threshold dose below which there is no harmful effect. As the dose increases, the severity of effect increases up to a level that ultimately, at least theoretically, would be fatal. In addition, as the dose increases, the proportion affected also increases.

Other harmful agents act by eliciting an immunologic or other hypersensitivity response (Figure 1B). With these agents, such as those that cause asthma, dermatitis, and allergic alveolitis, many persons experience no untoward effect regardless of dose. But increasing doses may increase the likelihood of sensitization nonetheless, thus increasing the proportion of people who are affected subsequently. Once sensitization occurs, however, the severity of reactions is usually independent of dose and may occur at a very low level of exposure. Finally, there are agents that interact with genetic material to cause mutations or initiate cancers (Figure 1C). With these agents, even the administration of the smallest dose creates some chance of a harmful effect. The risk of disease at the lowest end of the dose-response curve may be only theoretical or unmeasurable (e.g., the risk of lung cancer from smoking one cigarette). In this situation, as with agents inducing hypersensitivity, the dose does not greatly affect the severity of disease once it is present, but the probability of disease increases as the dose or exposure increases.

Although these relationships are different, the importance of dose in arriving at a correct diagnosis, providing treatment, and preventing disease remains crucial. As the subsequent sections of this chapter make clear, successful evaluation and management of the patient suspected of having a disorder of environmental origin or who has a risk for such a disorder depends on the physician's ability to assess the patient's recent and past exposure dose, at least qualitatively.

5. People differ substantially in their responses to noxious exposures.

Humans sometimes differ remarkably in their responses to environmental exposures. These differences may be due to a wide range of factors, including genetic differences in metabolism, age, gender or size, co-exposures to environmental substances that may interact with agents of interest, co-existing morbid conditions, or complex behavioral factors. The major principles that underlie this variability are discussed in Chapter 7. For present purposes, it is important to recognize such variability, which frequently obscures the relationship between environmental exposures and health effects. For example, a health problem in one among many individuals exposed to a harmful agent may suggest an alternative explanation when in fact only that individual was at risk at that dose of exposure. Similarly, the fact that many workers have functioned without adverse consequence around a chemical or process may wrongly convince an employer or susceptible co-worker that the environment is safe. From the practitioner's perspective, it is important to recognize that although the pattern of occurrence of illness in a population may be a vital

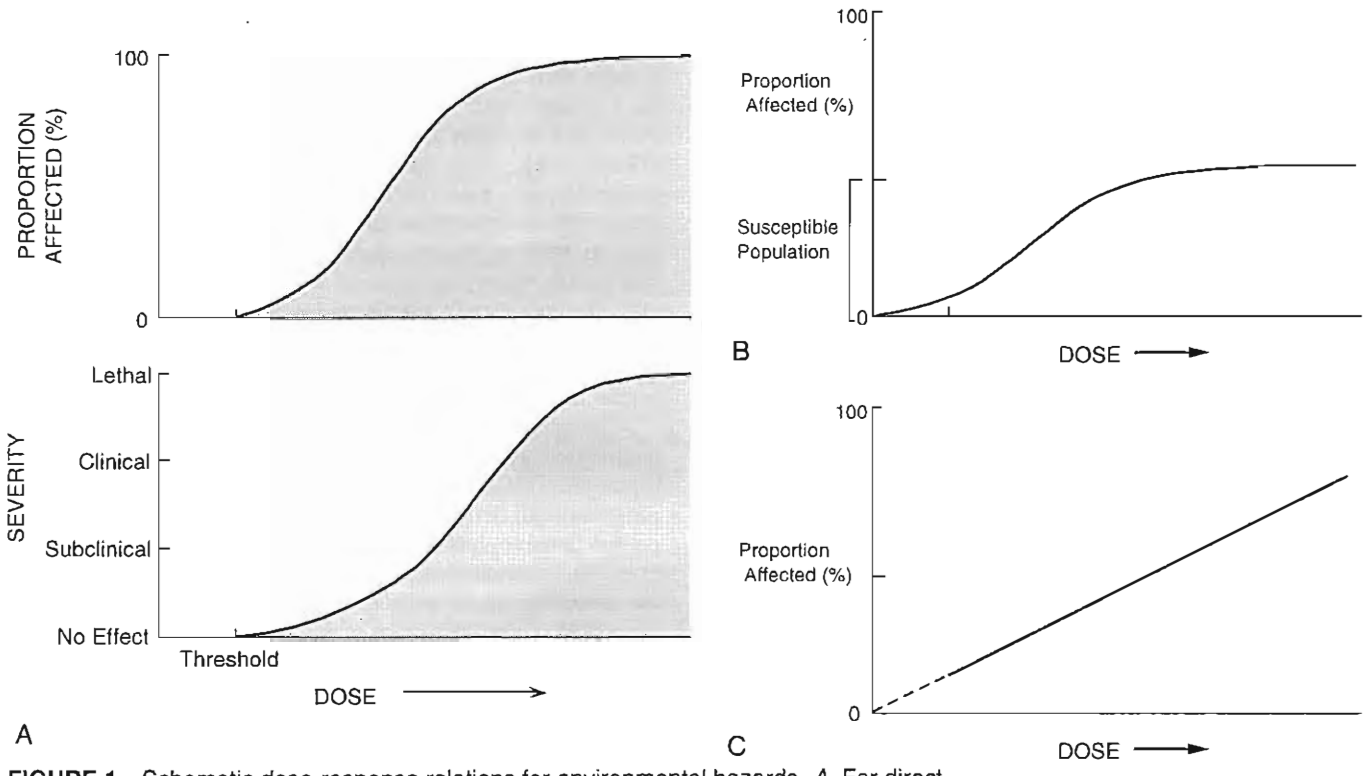

FIGURE 1 Schematic dose-response relations for environmental hazards. *A,* For direct-acting agents, there is a threshold for each individual, followed by increasing severity with rising dose. Similarly, a rising fraction of the exposed population is affected as dose rises; eventually everyone is affected. *B,* Indirect-acting toxins affect only susceptible individuals. The dose determines what proportion of these individuals are affected. Note that dose may not determine the severity of the reactions, which may be more related to host factors. *C,* Carcinogens are believed to cause disease as a linear function of dose. The shape of the dose-response curve at very low doses *(dotted line)* is difficult to determine directly from studies; it is often assumed to be linear, but this assumption is controversial for some carcinogens.

clue and should always be sought, the absence of a pattern or the presence of a confusing one may be a function of variability within the population.

Clinical Evaluations

In addition to the usual methods of clinical diagnosis, three tools are special to OEM practice: the occupational and environmental history, the environmental evaluation, and the use of specialized tests to establish causal associations. Despite variations in applicability, the principles are common to every case.

OCCUPATIONAL AND ENVIRONMENTAL HISTORY AND THE ENVIRONMENTAL EVALUATION

The occupational health history is fundamental to the assessment of the work-relatedness of health problems; as such, even in abbreviated form it should become a routine component of a comprehensive health history. The environmental history supplements the occupational health history by probing for the presence of nonoccupational factors and their possible role in the disease process.

The occupational and environmental history has multiple purposes:

1. To increase awareness of occupational and environmental factors. It is more the exception than the rule that clues to the potential role of these factors emerge from the physical examination or routine laboratory testing. Unless this history is specifically elicited or otherwise offered by the patient, the opportunity will be lost to consider occupationally and environmentally related disease or risk.
2. To make accurate medical diagnoses. Failure to obtain the history in the setting where occupational and environmental factors have played a role inevitably results in at least a partial misdiagnosis. For example, if fatty liver disease is correctly diagnosed but is attributed solely to alcohol overconsumption when solvent exposures have also played a role, then the diagnosis of alcoholic fatty liver disease is not correct and important treatment interventions will be overlooked.
3. To prevent the development of occupational and environmental disease. By using the occupational and environmental health history as a screening tool, identification of exposures to potentially hazardous factors can result in the reduction or elimination of these exposures. This factor may be beneficial in the setting where exposures cause diseases of long latency, as well as those responsible for acute and recurrent conditions. Identifying past asbestos exposure, for example, may render counseling about smoking cessation

more effective when this counseling is provided in the setting of education about the synergistic effect of exposure to both carcinogens. In the case of exposures causing acute conditions, for example, pulmonary allergens such as Western red cedar, interventions to decrease exposure are likely to reduce the person's risk of subsequently developing hypersensitivity.

4. To prevent the aggravation of underlying medical conditions by occupational and environmental factors. The smoker with chronic bronchitis who is exposed to respiratory irritants in the workplace will, regardless of effectiveness of smoking cessation interventions, benefit by reducing his or her exposure to identified respiratory irritants. Similarly, in addition to optimizing glucose control in the individual with diabetes mellitus, avoidance of exposure to agents that may cause peripheral neuropathy is also an important intervention, because the individual predisposed to a peripheral neuropathy of any cause may be at increased risk for damage from environmental peripheral neurotoxins.

5. To identify potential workplace hazards. In addition to using the occupational and environmental history as a screening tool to identify and ameliorate the risk of exposure to hazards, the history can help identify factors that would otherwise not be suspected as injurious—for example, the worker who presents with a persistent, dry cough may have been exposed to an irritating or sensitizing agent, initiating bronchial hyperresponsiveness manifested solely as cough.

6. To detect new associations between exposures and disease. The field of occupational and environmental medicine is rapidly evolving; as more interest and attention are paid to environmentally induced illnesses, more is learned about the nature and extent of adverse effects of specific agents. Perhaps no other field has the potential to uncover, through the evaluation of an individual patient, a previously unknown association between exposure and disease. Examples include adding to the list of now over 200 agents known to induce specific asthmatic responses, identifying new neurologic syndromes as chronic sequelae of past intoxications, and discovering new renal and hepatic toxins.

7. To establish the basis of compensation for occupational and environmental disease. Whether for workers' compensation for occupational disease or liability claims, the physician often plays a key role in determining the likelihood that an environmental exposure has caused a given medical condition. The patient's history of exposure—its onset, intensity, and duration—sometimes alone or in conjunction with other available exposure information, is fundamental to this assessment.

8. To help establish rapport with patients. This last benefit of employing the occupational and environmental health history in many ways is a secondary and unexpected bonus to the original objectives. In our experience, it is remarkable how often encouraging an otherwise taciturn person to describe the details of his or her job facilitates a more relaxed and congenial medical evaluation. Demonstration of a physician's interest in activities fundamentally important and often near and dear to the patient can lessen anxieties attendant with first-time physician-patient encounters.

Components of the Occupational and Environmental History

In any medical evaluation, the occupational and environmental history can be obtained in several ways. One approach is to integrate a series of key questions directly into the routine health history. Another approach is to incorporate a screening history with all new visits, selectively updating this procedure as indicated. In either approach, however, the occupational and environmental history has two main components: (1) the employment and exposure history and (2) the occupationally and environmentally related health history. The first component contains information about current and past jobs as well as nonoccupational environmental exposures. The health history component uses questions to elicit information about health problems and symptoms in relation to specific exposures and work settings, and about the existence of symptoms or illnesses in co-workers, household members, or community residents.

A sample history form that can be self-administered and maintained as part of the patient's data base is shown in Figure 2. This form can serve as a screening tool; clinical judgment will determine when it is appropriate to take a more comprehensive history. Because in some clinical settings even this shortened form may not be readily administered, we are often asked what few questions should be asked of all new patients. A survey of members of the United States Association of Occupational and Environmental Medicine Clinics (AOEC) found the following three questions essential:

1. Please describe your job.
2. Have you ever worked with any health hazard, such as asbestos, chemicals, noise, or repetitive motion?
3. Do you have any health problems that you believe may be related to work?

The following section describes the elements of the two core components of the occupational and environmental health history in more detail.

Work and Exposure History

This component of the occupational and environmental health history contains information different from that routinely obtained in the clinical setting. Nonetheless, many of the objectives of history-taking are similar, particularly those that include identifying in an individual risk factors that indicate the need for prevention or intervention strategies.

The following discussion is relevant to information about the current or most recent job and, in some instances, the job of concern for the problem under evaluation. If a patient is being evaluated for suspected occupational asthma, the key to a successful diagnosis is to focus on the job when the patient first began having symptoms. In addition to asking for the patient's job title (or occupation), it is important to know the nature of the job. This information can be obtained by asking additional questions about the industry—a painter in a shipyard is subject to different exposures than a painter in a residential setting. Hence, the key question is, "Tell me what you do on your job?" If the job is already familiar to the physician, then the question may be modified; for example, one may ask "Is there anything you do now that is different from past jobs where you've been an electrician?" It may be helpful to ask the patient to describe a typical work day.

The screening history inquires about the use of protective equipment. Although the provision of good protective equip-

I. Work and Exposure History

A. ***Current Employment***

Questions 1–7 refer to your current or most recent job.

1. Job title_____
2. Type of industry_____
3. Name of employer_____
4. Year job began_____
   Still working?
   Yes_____ No_____ If no, year job ended_____
5. Briefly describe this job, noting any part that you feel may be hazardous to your health.
   _____
   _____
6. Do you wear protective equipment on this job?
   Yes_____ No_____ If yes, check equipment used:

Gloves_____	Air supply respirator_____
Mask respirator_____	Coveralls or aprons_____
Hearing protection_____	Safety glasses_____

7. In this job, are you exposed to any of the following?
   If yes, mark those to which you are exposed:

   Fumes and dusts_____ Elements and metals_____
   Solvents_____ Other chemicals_____ Noise_____
   Vibration_____ Excess heat/cold_____
   Emotional stress_____ Other_____

B. ***Employment History***

It is important that we know all the jobs you have had. Job #1 is your current or most recent job. Beginning with the job before this one—Job #2—please fill in as much of the information requested as you can remember, and continue to do so until all previous jobs have been listed. Include any military service you have had. If you need additional space, use the back of this form.

	YEARS From — To	JOB TITLE	EXPOSURES
Job #2			
Job #3			
Job #4			
Job #5			
Job #6			
Job #7			
Job #8			
Wartime employment			

C. ***Other Exposures***

1. Does anyone in your household work at a job that you suspect involves exposures that may be brought home from work (e.g., asbestos fibers on clothes)? Yes_____ No_____
2. Are there any industries in the area in which you live that may pollute your environment? Yes_____ No_____
3. Do you have any hobbies that expose you to chemicals, metals, or other substances? Yes_____ No_____
4. Have you ever smoked cigarettes? ("No" means less than 20 packs of cigarettes in your entire life.) Yes_____ No_____
   If yes, please answer the following:
   a. Do you now smoke cigarettes (that is, as of 1 month ago)? Yes_____ No_____
   b. How many years have you smoked?_____
   c. Of the entire time you have smoked, about how many cigarettes per day do or did you smoke on the average?_____

II. General Health History*

1. Is there any particular hazard or part of your job that you think relates to your problems? Yes_____ No_____
2. Do any of your coworkers have problems or complaints similar to yours? Yes_____ No_____

*For each positive response to review of systems, ask whether symptoms are better, worse, or no different in association with work.

FIGURE 2 A sample of a screening occupational and environmental history form, which can be self-administered and serve as the basis for a more comprehensive history. (From Rosenstock L, Cullen MR. *Clinical Occupational Medicine*. Philadelphia, W.B. Saunders, 1986.)

ment should mitigate risks of exposure, it must be kept in mind that those who use protective equipment are often at increased risk for work-related illnesses—the protective equipment serving as a warning of hazardous exposure.

The patient should be asked directly about potentially hazardous exposures that are present at work—whether of biologic, chemical, physical, or psychologic origin. A checklist approach (as illustrated in Figure 2, the sample history form) can be used to direct this inquiry. If a patient gives a positive response to exposures within a category, then further information can be obtained about specific exposures. For an overview of the patient's occupational and environmental history and for an evaluation of those conditions of long latency—such as cancer and pneumoconioses—the occupational and environmental history must include information about past jobs and exposures and potential important exposures in the environment. An abbreviated history of all employment is provided in the sample history form. Sometimes an individual omits information about employment during military service; therefore, this information, which may indicate that the individual was subject to other toxic exposures, should be specifically sought.

Many workers are well informed about specific exposures. In other instances, however, the exposure history requires further study to identify specific constituents of products and exposure levels. Because consideration of the exposure dose is important in identifying and managing occupational diseases, the history is important in establishing the level of exposure. A similar approach can be taken to screen for nonworkplace environmental exposure. Although it is by no means precise, the patient's assessment of relative levels of exposure (i.e., low, medium, high) for specific agents can be valuable. One way of eliciting this information is shown in Figure 3, a portion of a comprehensive occupational and environmental history that can also be self-administered. Here, the patient is given an opportunity to report potential exposure to one of 46 agents or hazards that appear or have appeared in the current or any past job, as well as in nonoccupational, environmental settings ("any activity outside paid work"). Summary scores within or across different cate-

The questions below are an important part of our evaluation of your problem. Below is a list of agents or exposures that you may have encountered in your work or outside work.

The first set of boxes — marked A — refers to your current or most recent job (job #). For any agent or exposure that you have worked with in this job, mark YES and whether you think the exposure was of low, medium, or high amount.

Do the same for the next set of boxes — marked B — which refer to any previous job (any job aside from job #1). And then do the same for the last set of boxes — marked C — which refer to any activities outside paid work, such as housekeeping, student activities and hobbies.

Example: An example of a response is shown in the box below. Here, a worker is currently employed in construction and has occasional exposure to asbestos in repairing old buildings. However, previous work in a ship yard during the war exposed him to large amounts of asbestos. He has no known exposure to asbestos outside of work.

	A. Current or Most Recent Job (Paid Work)				B. Any Previous Job				C. Any Activity Outside Paid Work			
LIST OF EXPOSURES	YES	IF YES CHECK ONE Low	Med	High	YES	IF YES CHECK ONE Low	Med	High	YES	IF YES CHECK ONE Low	Med	High
Example Asbestos	✓	✓			✓			✓				
1. FUMES AND DUSTS												
Asbestos												
Plastic Fumes												
Welding Fumes												
Fumes (other)												
Glass (e.g. Fiberglass)												
Silica (e.g. Sand)												
Plaster												
Wood (Specify Type(s) If Known:_____)												
Other (Specify If Known:_____)												

FIGURE 3 Sample of detailed self-report form for specific occupational and environmental exposures.

gories can also be derived, and these scores have been shown to correlate with an industrial hygienist's independent assessment of the potential hazards in a given job.

The nature and use of protective equipment is an additional clue about levels of exposure. It is desirable to gather information about the general cleanliness of the workplace and the adequacy of ventilation. Finally, for some exposures such as solvents, the description of symptoms in relation to exposure provides evidence that excessive exposure levels may have been encountered.

General Health History

The traditional part of the health history—including the chief complaint and review of systems—needs to be appropriately expanded to assess the possible relationship between occupational and environmental exposures and health problems. In each of the chapters in Section Three of this text, specific questions pertinent to each disorder under discussion are identified. A few questions should be asked of all patients. If nothing else, patients should be asked whether they feel their

	A. Current or Most Recent Job (Paid Work)				B. Any Previous Job				C. Any Activity Outside Paid Work			
	YES	IF YES CHECK ONE Low	Med	High	YES	IF YES CHECK ONE Low	Med	High	YES	IF YES CHECK ONE Low	Med	High
2. ELEMENTS AND METALS												
Aluminum												
Arsenic												
Cadmium												
Chromium												
Copper												
Lead												
Mercury												
Nickel												
Zinc												
Other (Specify If Known: _____)												
3. SOLVENTS												
Alcohols (e.g. Methyl, Wood)												
Benzine (Gas), Petroleum Ether												
Benzene, Toluene, Xylene												
Carbon Tetrachloride												
Paint, Varnish, Degreasers												
Tri-, Tetrachloroethylene												
Other (Specify If Known: _____)												
4. OTHER CHEMICALS												
Acids												
Alkali (Caustics)												
Ammonia												
Detergent and Soaps												
Dyes												

FIGURE 3 *Continued*

Illustration continued on following page

health problems are occupationally or environmentally related. In many instances, the first suspicion about an occupational disease arises from the patient's concern about the effects of exposures. Although this suspicion may prove to be unfounded, such concerns should always be taken seriously.

The presence of similar symptoms or complaints among co-workers may be an important clue to the existence of an occupationally related disease. Particularly for agents acting as direct toxins (see principle 4, earlier), the presence of symptoms among others similarly exposed may indicate that a workplace exposure is implicated and that the exposure levels are excessive. Even for substances producing sensitization, such as chemical asthmagens, finding other persons in the workplace with similar symptoms may help identify the offending agent. The report of the presence or absence of symptoms in co-workers should, however, be interpreted with caution. For numerous reasons, only one worker may

	A. Current or Most Recent Job (Paid Work)				B. Any Previous Job				C. Any Activity Outside Paid Work			
	YES	IF YES CHECK ONE Low	Med	High	YES	IF YES CHECK ONE Low	Med	High	YES	IF YES CHECK ONE Low	Med	High
Formaldehyde												
Pesticides												
Plastic Resins												
Other (Specify If Known: _____)												
5. MISCELLANEOUS												
Heavy Lifting												
Improper Lighting												
Excess Heat or Cold												
Emotional Stress												
Plant Products												
Ionizing Radiation (e.g.X-ray, Radioisotopes)												
Nonionizing Radiation (e.g. Microwave, UV)												
Noise												
Sitting or Standing in Same Position												
Vibration												
Other (Specify If Known: _____)												

FIGURE 3 *Continued*

be affected. These reasons may include differences in actual exposures, idiosyncratic reactions to exposures, or other differences in host susceptibility.

An important component of this part of the history, particularly for symptoms reflecting acute and recurrent conditions such as dermatitis or asthma, is the relationship of symptoms to time at work and to specific exposures and work processes. Patients should be asked whether anything different at work preceded the onset of their symptoms, such as handling a new task, new product, or new job assignment. Patterns of symptoms in relation to time at work may provide helpful hints to both the diagnosis and the etiologic agent. Several patterns are described below; these patterns may occur alone or in combination in an individual patient. Inquiry about timing of symptoms in relation to nonworkplace environmental exposure is essentially no different from inquiry about workplace exposures, and questioning should proceed along the general lines described below.

1. Change in symptoms during the work day. For a number of substances that induce their effect as direct-acting toxins, such as solvents or nonspecific dusts and respiratory irritants, the patient may arrive at work free of symptoms only to experience their onset in a predictable fashion after arriving at work. A person with solvent overexposure, for example, may report the onset of headache and dizziness within 1 to 2 hours after arriving at work, and the abatement of these symptoms occurs within a few hours after leaving work. For agents causing immediate hypersensitization responses, such as flour in bakers sensitized to it, the patient often describes the onset of symptoms consistent with asthma (whether exhibited as cough, chest tightness, shortness of breath, or wheeze) within minutes of exposure. Other symptoms consistent with this type of exposure may also occur, such as upper respiratory and mucosal symptoms, including coryza, eye discomfort, and itching.

Symptoms may not occur similarly on all work days, and they may vary depending on the level of exposure (e.g., when ventilation is on or off, climatic conditions, specific job responsibilities) and other host factors (e.g., extent of recent exposure, medication use).

2. Change in symptoms over the work week. For several agents, of which cotton dust exposure is the classic example, there may be a higher level of symptom intensity on first returning to work after several days away ("Monday morning fever"), although symptoms (and concomitant pulmonary function decline) may worsen gradually as the week passes. In some instances, symptoms may be apparent only

at the beginning of the work week—in metal fume fever, for example, the symptoms of this flulike illness are most likely to occur on a Monday or Tuesday, with the individual exhibiting loss of the tolerance acquired during the previous work week. On the other hand, workers exposed to nitrates may get headaches both in the beginning of the work week and on weekends. Weekend flare-ups are associated with a withdrawal syndrome from these potent vasodilators, with associated vasospastic coronary or cerebral events also occurring most commonly on weekends.

3. Change in symptoms on weekends and on vacations. A number of work-related syndromes result from exposures that have immediate or early effects, such that associated symptoms resolve within hours or days and occasionally with longer periods away from work. The effects of overexposure to solvents are examples of this type of temporal change. Because some solvents have longer half-lives than others, it may take days, in fact, for the acute effects of solvent intoxication (characterized by headaches, lightheadedness, dyspepsia, and irritability) to resolve. For individuals who are chronically exposed to these agents, these effects may persist longer but should gradually resolve unless permanent sequelae, such as chronic encephalopathy, have intervened.

Trials of removal of the individual from work to assess the effect of withdrawal from exposure have an important diagnostic role in occupational medicine. Examples include removing the worker because of exposure to potential hepatotoxins to determine whether or not several weeks or months away from work may result in resolution of dysfunction; removing the worker from respiratory irritants to assess resolution of pulmonary symptoms and improvement of function; removing the worker with carpal tunnel syndrome from exposure to repetitive motion, and removal of the worker with contact dermatitis from exposure to allergens or irritants in the workplace.

4. Onset of symptoms away from work. A few agents are known to have unique patterns of inducing effects in relation to time of exposure. Some occupational asthma-inducing agents, for example, cause as the most common pattern of sensitization a delayed reaction about 8 to 12 hours after exposure, often initially exhibited as nocturnal asthma. Toluene diisocyanate (TDI) and Western red cedar are two well-studied agents associated with this pattern, which is characteristic of exposure to low-molecular-weight compounds. Typically, the patient presenting with new onset asthma from these causes describes the first awareness of wheezing on nights following days at work; then over time, with the development of nonspecific bronchial hyperreactivity, this clear-cut association with time at work may be lost.

As mentioned earlier, some agents such as nitrates may not exert their effects until their levels are lowered, so that symptomatic vasoconstriction may occur on removal of the individual from exposure. Some solvents, notably trichloroethylene, may cause a reaction similar to that of the drug Antabuse; affected individuals may experience a flushing response when consuming even modest amounts of ethanol, even hours after the occupational solvent exposure has ceased.

5. Other experiences with work-related events. The last component of the modified general health history is to inquire about previously diagnosed work-related injuries and illnesses, including any experience with workers' compensation. In addition to completing the historical database, this information may be helpful in recognizing previous hazardous work.

The Comprehensive Work and Exposure History

At times, a more detailed employment and exposure history is indicated. This type of history expands on key elements of the screening history, obtaining information about each potentially relevant job or about exposures of concern outside work. In addition, questions about workplace size, ventilation, and health and safety practices can also be helpful. A systematic query about exposures to specific hazards on the current or past jobs and of those encountered outside work may also be initiated (see Fig. 2). Finally, asking the patient to diagram his or her workplace can provide additional useful information about the setting, including possible exposures from nearby work processes. A sample of a question pertaining to this inquiry is provided in Figure 3.

The Validity of the Occupational and Environmental Health History

The occupational and environmental health history can be obtained by using a self-reported questionnaire or by interviewer. In either case, the question of the accuracy of exposure information provided by the patient is often raised, particularly if the information is used in settings that may have adversarial connotations.

Several investigators have studied the reliability and validity of this part of the health history. In the occupational and environmental history, self-reported exposure information has been evaluated in comparison with other measures, including (1) personnel records; (2) outcome measures, such as vital status, chest x-ray studies, and cancer registries; and (3) information obtained by interviews with individuals knowledgeable about workplace assessments. All studies have found some varying degrees of association between self-reported information and data obtained from other sources. These results are reassuring when the occupational and environmental history is the main or only source of exposure data. Wherever possible, of course, self-reported exposures should be supplemented by other information, discussed in more detail in the next section. The need for precise data about the nature and extent of specific exposures varies on a case-by-case basis, but in practice, the information obtained directly from the patient often is sufficient to make an accurate and supportable diagnosis.

The Environmental Evaluation

Unfortunately for the practitioner, for many reasons the history is insufficient for an accurate diagnosis. These reasons include (1) lack of specificity about the identity of hazards; (2) inadequate information about exposure level; (3) recall biases (greater attention to exposures that were at the time bothersome or otherwise are perceived as being causal); and (4) other biases, e.g., patients fearful of possible job loss may under-report exposures, and litigants may exaggerate the intensities of exposures and their apparent effects.

For these reasons, an essential component of the work-up is obtaining additional exposure information whenever there

is reason to believe that it may alter or modify what is learned directly from the history. This additional information serves several purposes: (1) to learn the true chemical or physical hazards to which the patient has been exposed, (2) to establish information about the dose of exposure, and (3) to corroborate or modify the information that has been obtained directly from the patient. This includes both environmental and prior medical information that may clarify perceptions or reports of the relationship between exposures and effects.

The section that follows is a summary of avenues that may be used to obtain environmental and related health information. Strategies for obtaining this information are variable, and issues about confidentiality should always be considered (see discussion later in the chapter). A further discussion of some of these sources is provided in Chapter 10, Industrial Hygiene.

1. Prior medical records. These records tend to be accessible and obtainable without risk of any disclosure for the patient. Although these records may not further etiologic assessment, they can confirm the patient's complaints at previous occasions and provide objective measures of his or her physiologic status. This information can help corroborate or modify the history and may be useful in applying one of the cardinal principles of occupational and environmental diseases—the biologic plausibility inherent in the time between exposures and effects.

2. Exposure records from an employer. Under recent regulations in the United States, employers are obligated to maintain material safety data sheets (MSDSs) for each potentially hazardous material with which employees may come in contact. Further, under federal and state laws, the employer is obligated to make this information available to the employee or his or her physician in a timely fashion, together with any available information about exposure doses (e.g. air sampling information, blood tests). Despite the benefits of this recent increase in available information, there remain numerous problems. The MSDSs themselves are often of limited quality. Much potentially useful information is lacking, such as information on minor ingredients that may be responsible for important health effects, especially allergic ones. In addition, the health information is often presented uncritically and without adequate discussion. In fact, for many of these MSDSs, the most useful information is the telephone number listed to call for additional help. Employers or others working directly or by contract to them (e.g., physicians) are also able on occasion to provide useful information, including the results of past workplace assessments.

3. Health and regulatory agencies. Often, a workplace or environmental hazard has been inspected by an agency with regulatory authority. The results are generally available to physicians and, if so, are an excellent source of information. Nonetheless, one limitation is that workplace inspections are generally conducted by industrial hygiene or safety personnel for the sole purpose of ascertaining whether or not there has been adherence to various regulations. Further, the regulations may not reflect the possible harm that can occur at levels lower than the "acceptable limits."

4. Unions and community groups. Although they are not in the same position as current or past employers, who have direct access to exposure information, many such organizations have taken environmental health issues seriously and have obtained substantial amounts of information, often of good quality, that is relevant to their members or residents of a community.

5. Direct site visit. When the issue is a current or recent exposure, there is perhaps no more satisfactory way to evaluate the environment than direct on-site inspection. This practice offers the advantages of contacting employees at the site, relating the history to observable facts, and assessing for exposure and dose. The opportunity to correlate illness directly with the work environment is one of the special advantages of clinicians who are based at the workplace. Conversely, lack of this capability puts the diagnostician at a considerable disadvantage. Whether he or she is based inside or outside the plant, the clinician must recognize that the direct assessment of exposures is a highly complex and specialized process, requiring assistance of an industrial hygienist or a comparably trained professional (see Chapter 10).

DIAGNOSTIC DECISION MAKING

Specialized Use of the Laboratory

Clinicians without experience in OEM diagnosis and practice may conclude that the laboratory can be used to compensate for the difficulties in obtaining reliable information about exposure or putative effects. This is not surprising, given the remarkable progress of clinical toxicologists in quantifying poisonings and the burgeoning array of technical capabilities that now allow measurement of many contaminants down to the level of parts per trillion in numerous body tissues. Unfortunately, at this time, the overall role of the laboratory in OEM remains limited. In this section, the role of the laboratory in OEM is described. Each of the organ system (Section Three) and exposure chapters (Section Four) in the text further details the role of the laboratory in the assessment of particular hazards and diseases.

Despite some overlap, laboratory tests can be conceptualized in one of three ways:

1. Tests that elucidate pathophysiology. These tests include almost all of the relatively routine tests, such as imaging studies, chemistry panels, and hemograms. Also included are tests that play more specific roles in OEM diagnosis, such as nonspecific inhalational challenge tests (e.g., methacholine challenge test) or measurement of enzyme levels (e.g., cholinesterase or δ-aminolevulinic acid dehydratase [ALA] test). The net effect of this kind of study is to clarify what is or is not wrong with the patient. Some such studies, of course, may have considerable value in the subsequent task of assessing causality, but the primary role is to evaluate effects rather than exposures.

2. Tests that elucidate or quantify exposures. Other tests may be performed to establish the presence of a suspected causal agent in an organ or body tissue. Such tests are often referred to as biologic monitoring because, in effect, they use the body as a sampling device to assess exposure. Examples include measurement of the whole blood lead level, which documents that lead at a given concentration is present in red cells, or polarizing light microscopy on a lung biopsy searching for crystalline silica particles. These kinds of studies may lead to inferences about actual health effects, but they do not

directly measure health effects, only exposure. Although there may be some rationale in using a measure of exposure as a means for identifying "cases" of disease (e.g., identifying an adult with a lead level over 40 μg/dl as "lead poisoned" for surveillance purposes), the identification of the toxin should not be used as proof of the effect that may be thought to exist.

3. Tests that directly assess the relationship between an exposure and an effect. Many tests are more dynamic in the sense that they inherently capture causal information. An example is determining the presence of a specific antibody to a sensitizing agent. The presence of antibody in such a case confirms both that exposure has occurred and that it has generated an immunologic reaction. Similarly, patch testing and specific inhalational challenge tests are types of tests that document that an exposure and sensitization have occurred and may even document the relation between the level of exposure and a specific health effect.

At times, a test of one of these three types may be used appropriately to establish information about another type. For example, zinc protoporphyrin in red cells, a measure of lead effect in the blockade of the enzyme heme synthetase, is a surrogate measure of lead exposure. Similarly, measurement of urine cadmium level is a good index of recent exposure in workers using the metal, as well as a good measure of the renal effect of cadmium: In individuals who have not had recent cadmium exposure but who have suffered impaired renal function, the affected kidney leaks stored cadmium, whereas the intact kidney will not. In this case, an apparent measure of an exposure is used to measure an effect.

Even when the logic for ordering a laboratory test is clear to the clinician, there remain several problems with the application of results to diagnosis.

1. Limitations inherent to the laboratory itself. The clinician must always be alert to the factors that limit the quality of any data that are returned from the laboratory. These include (1) the ability of the laboratory to detect a substance or an effect, (2) the reliability of the laboratory to measure a result, (3) the validity of the results, (4) the precision of the results, and (5) the standardization of the results.

2. Strategies for obtaining tests. Although many tests in clinical medicine do not vary significantly according to the time they are made (e.g., chest x-ray studies), others can be interpreted only on the basis of careful planning of how and when samples are obtained (e.g., plasma triglycerides). In many situations, the strategy for sampling is crucial to interpretation of results in OEM. For tests of effects, the timing must be planned to avoid either missing the effect or confounding one effect with another. An example of the first situation is the use of spirometry to detect bronchospasm; even an individual with severe asthma may have normal spirometry if the test is not timed to coincide with an expected effect. On the other hand, an audiogram performed within several hours of noise exposure is likely to document the temporary effects of noise but may be incapable of determining baseline hearing function.

Failure to consider testing strategy may also limit the interpretation of tests that directly assess the relationship between exposure and effect. For example, it is now well recognized that early in the course of occupational asthma, sensitization to agents such as isocyanates may rapidly reverse after removal of the individual from exposure. Therefore, even in a previously sensitized individual, a specific challenge with the agent may fail to produce bronchospasm if that person has been away from the exposure for a period of time before testing.

3. Interpretation of normal and abnormal results. Laboratories commonly supplement reports with statements as to whether or not a result is normal. By convention, the term normal usually means that a test result falls within the range of results for 95% of the healthy population. For a few tests, other guidelines are used by convention, such as within 20% of the mean result of a reference group. In OEM practice, laboratory test results need to be placed in their larger context. For example, a young worker exposed to a known respiratory tract toxin may have normal lung function on spirometry, yet comparison with a previous value from the same individual may document that loss in function has occurred. Conversely, a lead battery worker may be identified by the laboratory as having an abnormal whole blood lead level of 20 μg/dl. Although this level is higher than that found in the general population, it is unlikely to reflect significant lead toxicity, nor is it an unexpected value in a well-controlled battery plant. Recognition that this level of exposure is higher than that seen in other adults may have some value but cannot be used the basis for the diagnosis of lead poisoning.

Further, as with all tests, the likelihood that an individual with an abnormal test in fact has the disease under evaluation (positive predictive value) is influenced not only by the test's sensitivity (that those with disease will test positive) and specificity (that those without disease will test negative) but also by the prevalence of the disease in the specific population from which the individual comes. For example, a minimal finding of interstitial fibrosis on a chest radiograph in an asbestos-exposed worker is, in itself, more predictive of disease than is the same finding in someone who has not been exposed (see later).

The Available Databases for Diagnostic Inference

Having completed the basic evaluation, including the history, environmental exposure assessment, physical examination, and basic laboratory evaluation, the information needs to be interpreted to answer three central questions:

1. Given what is already known about the patient, is it plausible that he or she has a disease related to environmental exposure?
2. If it is plausible, how likely is it, based on the exposure assessment and clinical pattern?
3. Given the exposure assessment and clinical setting, how should various laboratory tests be interpreted? What further studies or tests offer the possibility of substantially altering the likelihood that a disease is related to an environmental exposure?

In this section, we address the task of identifying existing sources of information and establishing how these sources can be used to assist in arriving at a diagnosis. Many different types of resources are available to address questions about disease plausibility and likelihood. Most sources, but not all, rely on a review and assessment of the scientific

literature related to the exposures and the diseases in question. The most important are:

1. Exposure assessment databases. For a variety of reasons, it is often not possible to confirm directly the occurrence of an exposure of interest or to obtain a reliable estimate of dose. Fortunately, there are many available resources for translating historic information into at least semiquantitative estimates about exposure and likely dose. Texts, including this one, often summarize the hazards typically associated with particular kinds of activities and the range of doses to which people are exposed. Large surveys, such as the ones performed periodically by the National Institute for Occupational Safety and Health (NIOSH), allow determination of the jobs and industries where certain hazards are likely to be found. Scientific papers, often from the industrial hygiene literature, can frequently provide valuable summaries that may be relevant to a particular clinical problem.

2. Epidemiologic databases. When there is some basis for estimating exposure and dose, epidemiologic studies often provide the most compelling data relating exposure to disease. However, these studies vary in quality and in applicability to the patient under evaluation. Epidemiologic studies can provide excellent evidence that an exposure causes an effect in humans. Moreover, such studies often establish certain limits for biologic plausibility of an association between exposure and disease, such as the latency between exposure and increase in disease risk. Further, these kinds of data are often helpful in the quantitative assessment of individual risk. If individuals who do precisely the same activity have been studied, quantitative determination of risk is relatively straightforward. Even if the patient's exposure setting differs from groups that have been reported, one can often learn enough about the patient's exposure to fit him or her into the range of exposures that have been studied.

Access to epidemiologic studies is readily achieved by using available texts and computerized literature searches. Less easy is determining the quality and relevance of a specific study to a particular patient. Many issues related to the quality of epidemiologic studies are discussed in Chapter 9. The relevance of epidemiologic studies to the patient at hand is no less important. First, the exposure dose in the patient should be reasonably similar to the exposure dose of at least a portion of the study population. A given dose can be extrapolated to results at higher and lower doses, but this approach is not always valid biologically (see Chapter 8). Second, the population under study ideally should resemble the patient's demographic characteristics, such as age and gender. Unfortunately, most studies historically have been limited to white males, so there is often little choice other than to use the data on white males and modify the interpretation as needed.

3. Toxicologic databases. Epidemiologic data may be inadequate to use in the task of defining the likelihood that a patient has an effect from an environmental exposure. Alone or in combination with epidemiologic data, the results of animal studies performed under experimental conditions may be helpful. One advantage of these studies is that they often provide very strong evidence of dose-related effects of hazards. Further, animal studies may provide information about certain laboratory findings, such as the presence of toxins in diseased organs, biochemical changes, and histopathology. Modern toxicologic studies of this kind are plentiful and are easily identified by computer searches of the scientific literature. Good summaries are often available as well in texts and in monographs such as the toxicologic profiles compiled by the United States Agency for Toxic Substances and Disease Registries located in Atlanta.

A serious limitation of toxicologic studies, in addition to the obvious potential differences between species, is that most use convenient routes of exposure, such as gavage (tube feeding), and therefore differ from the route by which the patient may have been exposed. In addition, animal studies almost invariably depend on use of high doses of single toxins, and may require extensive extrapolation to be applicable to a clinical case. Additional limitations are identified in Chapter 8.

4. Clinical studies and case reports. Clinical reports and case studies, although limited because of the absence of a comparison population, often are exceptionally useful for clinicians in OEM. Compared with epidemiologic studies, very rich information is often available regarding the actual characteristics of the patients being reported and the specific nature of their exposure and dose. Specific clinical information of importance is also usually provided, including the results of a wide array of tests and descriptions of the severity of illness, clinical course, and response to treatment.

At their best, therefore, clinical case reports and studies often are sufficiently applicable to provide a rational basis for all subsequent steps. At their worst, clinical reports may create the illusion of a causal relationship between an exposure and an outcome that cannot be substantiated. Case reports relevant to an exposure, therefore, should be carefully reviewed, but additional weight should be given to them if corroborating evidence (e.g., toxicologic or epidemiologic) is also available.

5. Clinical experience. Although direct clinical experience may create certain biases of perception, this kind of experience can and should be incorporated among the available resources for drawing inferences about likelihood of effects, because exposed individuals with problems are far more likely to have been seen than those without problems. Although this database is not drawn from the "scientific" literature, the obvious relevance in terms of exposure profile and personal characteristics makes it extremely valuable. As a consequence, physicians when possible should consult those who may have previous experiences with patients like their own.

THE USE OF EPIDEMIOLOGY AND QUANTITATIVE REASONING IN DETERMINING THE WORK-RELATEDNESS OF DISEASE

The likelihood that a particular diagnosis, environmental or otherwise, is the correct explanation for a sign, symptom, or test abnormality is generally based on two factors: (1) the patient's demographic background, exposure history, and known other risk factors for disease, which helps determine the risk for the disease prior to the sign, symptom, or test abnormality (prior risk); and (2) for that diagnosis, how prevalent is the particular symptom, sign, or test result among people who have that disease.

The likelihood of a particular diagnosis can be calculated by multiplying the likelihood of each of these two factors. The following example illustrates this concept.

The chest x-ray study of a dust-exposed man reveals a very low-grade profusion of shadows (e.g., an ILO grade 0/1, see Chapter 11). Although these values fall within the usual definition of normal in that they are seen in healthy, unexposed men, the conclusion that this patient is disease free may well be wrong. In this situation, there are three diagnostic possibilities. First, the patient could have pneumoconiosis of the type suspected. Second, he could have a different respiratory disease that is subclinical. Third, he could be disease free. A theoretical example, provided in Table 1, demonstrates the likelihood of these possibilities.

1. The probability that he has pneumoconiosis is equal to his likelihood of having the disease (prevalence of disease in similarly exposed individuals) times the frequency with which test results like the one observed occur in people with this disease (false negatives, or 1-sensitivity). In other words, how often do men with pathologically confirmed pneumoconiosis due to this dust have grade 0/1 x-ray studies? If the tests are highly sensitive, the false-negative rate will be very low and the frequency with which the tests are negative is, therefore, very low. However, if the tests are not sensitive indicators of the disease, a high rate of false-negative results is to be expected. For example, for most pneumoconioses, the x-ray study is believed to be about 90% sensitive; 10% of those with disease at autopsy will have had prior normal x-ray studies. To give a numerical calculation to illustrate this case, let us assume that the prior probability of disease is 80% and that the sensitivity of the radiograph is 90%. In this population, even an individual with a normal radiograph has a 31% (8/26) likelihood of having disease (see Table 1).

2. The probability of another disease is calculated the same way. Assuming none is strongly suspected based on the history and physical examination, the prior likelihood for this disease would be very low. On the other hand, if the history or examination suggests that another disease is present, then the prior probability for this other condition would be high.

3. The probability of no disease is relatively easy to assess. It is proportional to the prior probability that the patient is healthy (1 − prevalence) times the proportion of normal test results in individuals without disease (specificity). If the prior risk of pneumoconiosis had been low, then the result of the x-ray study would have been strong evidence that pneumoconiosis is not present. However, in this case the normal x-ray study increases only somewhat the likelihood that the patient is truly disease free. A second test, such as lung function, might help resolve the issue.

TABLE 1 Example of Probabilities of Disease Given Test Results

	Pneumoconiosis		
Chest x-ray	Present	Absent	
Abnormal (≥ 1/0)	72	2	74
Normal (≤ 0/1)	8	18	26
	80	20	100

Prevalence = 0.8
Sensitivity = 0.9 (72/80)
Specificity = 0.9 (18/20)
Positive Predictive Value = 0.97 (72/74)
Negative Predictive Value = 0.69 (18/26)

Uses of Epidemiology to Determine the Probability of Work-Related Disease

In most workers' compensation and legal settings, one of the physician's roles in OEM practice is to establish whether or not it is probable (greater than 50% likelihood) that the patient's injury or disease is occupationally or environmentally related. Physicians, whose standards of scientific certainty are usually considerably higher than those of the legal field (for example, often at the 95% level that an observed association did not occur by chance), need to appreciate that a disease may be deemed work related (i.e., in legal jargon, with medical certainty or more probable than not) even when there remains significant uncertainty (up to 50%) about this judgment.

Epidemiologic or population-based data may be used to provide evidence of both the causal relationship between an exposure and an outcome and the likelihood that the exposure is related to the outcome in an individual case. Once significant associations are found in epidemiologic studies between exposure and disease (after controlling for the potential confounding of other variables), those criteria are also applied to improve the probability that significant associations are in fact causal. Relevant criteria include (1) the strength of the association, (2) appropriate dose-response and temporal relationships, (3) biologic plausibility, and (4) consistency with other studies. Although they are not fully conclusive, well-performed and interpreted epidemiologic studies can play an important role in determining the work-relatedness of disease in a person, using some of the additional guidelines below.

Relevant epidemiologic studies allow calculation of estimates of relative risk (RR, the ratio of the rate of incidence in the exposed compared to an unexposed or other comparison population) and attributable fraction (the proportion of cases of disease in a population due to an exposure and, therefore, avoidable if the exposure is removed). The concept of attributable fraction, known by many names, including attributable risk and etiologic fraction, has particular utility in determining the likelihood of importance of a hazardous exposure. Although these numbers refer to risks in groups, as shown in the following section, reasonable extrapolations from these numbers can often be made about risks in individuals.

The population attributable risk (PAR) is the proportion of cases in a population due to an exposure and is calculated as:

$$PAR = \frac{Pe\,(RR - 1)}{1 - Pe\,(RR - 1)}$$

where:

Pe = proportion of the total population exposed to factor, and
RR = relative risk associated with the factor.

For the sake of simplicity and illustrating how this formula can be applied in individual causation determinations, consider the case in which all in the population are exposed (i.e., Pe = 1), then $PAR = \frac{RR - 1}{RR}$.

For example, if all the members of a population are exposed to a factor, and there is a RR of 5 of disease in

relation to the factor, then the PAR = 80% (= (5 − 1)/5 × 100). If exposures and other population characteristics are similar in a second population, then it also can be assumed that this factor will account for 80% of cases of the disease. A short conceptual leap can be made to individual attribution: if an affected individual is similar (e.g., in age and gender) to those in the population and is similarly exposed (e.g., similar duration, intensity, and latency), then there is an 80% likelihood that the factor caused the disease in that individual.

This reasoning need not be limited to a single factor, either. For each factor, the PAR can be calculated and combined using the following formula.

$$\text{PAR (factor 1 + factor 2)} = \text{PAR (factor 1)} + \text{PAR (factor 2)} - [\text{PAR (1)} \times \text{PAR (2)}]$$

By this reasoning of assuming that all in a population are exposed and the relative risk is greater that 2, then the PAR is greater than 50% (where PAR = (2 − 1)/2 × 100%). Accordingly, if an affected individual is similar to the population in a study that has demonstrated a RR ≥ 2, then the legal test (that there is a greater than 50% likelihood that the factor caused disease) can be met.

The following section focuses on a specific example to illustrate this use of epidemiology, derived from actual data of the multifactorial etiology of lung cancer in smokers with heavy occupational asbestos exposure (asbestos insulators made in the United States). The calculations for risk for lung cancer are as follows:

RR (asbestos) = 5;
RR (smoking) = 10;
RR (asbestos + smoking) = 50

$$\text{PAR (asbestos)} = \frac{\text{RR (asbestos)} - 1}{\text{RR (asbestos)}} = 0.8, \text{ or } 80\%$$

$$\text{PAR (smoking)} = \frac{\text{RR (smoking)} - 1}{\text{RR (smoking)}} = 0.9, \text{ or } 90\%$$

$$\text{PAR (asbestos + smoking)} = \text{PAR(a)} + \text{PAR(s)} - [\text{PAR(a) PAR(s)}] = 0.98 \text{ or } 98\%.$$

It should be noted that in this example, there are two "more probable than not" or likely causes of lung cancer. Nonetheless, these data demonstrate that an individual who has lung cancer with similar characteristics to this population, regardless of smoking status, probably has asbestos-related cancer. The same is true of all asbestos-exposed workers who have at least as much exposure as those in populations found to have RRs of 2 or more. An individual can still have a significant increased risk for a disease due to exposure but may not meet the level of certainty demanded in some legal determinations; for example, in an affected individual having similar characteristics to a population with an RR of 1.5 [where PAR = (1.5 − 1)/1.5 = 33%], the factor can be said to have caused the disease with only 33% probability. It should be noted that the reliability of PARs is also an important factor in a final case evaluation. In cases in which the relative risks are stable (i.e., very narrow confidence intervals) and the patient is typical of the population studied, one can state these individual attributable risks with some assurance that they are valid estimates. When the studies are of limited power or give varying results, or if the patient's exposure can not be easily related to the study population, caution in using this method is appropriate.

ECONOMIC, ETHICAL, LEGAL, AND SOCIAL FACTORS IN PATIENT EVALUATION

Individuals seek the services of an OEM practitioner for a broad range of reasons. Among referred patients, the sources of referral are not limited to primary practitioners or other medical specialists; many are sent directly by such diverse parties as employers, lawyers, unions, insurance companies, and government agencies. The referral source may alter the content and basis for the evaluation.

Often, it is the patient who encourages the referral or who directly refers himself or herself. Patient expectations also have important ramifications, both during the diagnostic evaluation and after. Understanding patient expectations early in the patient-physician relationship is important.

In this section, we explore some of the major nonbiologic issues (e.g., legal, economic, and social) that arise in practice and discuss the ethical responsibilities that accrue in this practice domain.

The Agenda of Patients and Third Parties

The Patient's Agenda

There are three areas of relevant inquiry into understanding the patient's perception of and interest in an OEM examination: health perception and concern, job situation, and life situation.

■ Health Perception

Individuals usually seek health care because they are experiencing symptoms or because they are concerned about present or future health risks. These are also common, straightforward and credible reasons to seek OEM evaluation as well, whether it is mandated or voluntary. Changes in the societal view about chemicals and other hazards, notification requirements of new laws, and wide public attention to certain hazards have created more awareness about risk and, to some extent, confusion about risk. Individuals often have too little knowledge to apply probabilistic thinking and are often unsophisticated about the influence of dose on risk (see Chapter 4). At one end of the spectrum, patients may have been led to believe that a minor exposure has conferred an imminent risk of lethal disease. At the other end, there are disbelievers who underestimate or deny major risks and fail to act appropriately.

The perception of risk and harm may be closely linked to social issues, such as a community's fight against a toxic waste site or a union's struggle for a new contract. Incorrect information may have come from a highly respected source within the patient's circle (including a poorly informed physician or other health professional). Moreover, correct information may sound disturbingly like information provided by an employer or polluter or the government, which the patient has come to mistrust.

For these reasons and more, it is important to know not only what the patient believes might be going on but what the basis for the belief is. Response to this simple line of inquiry often discloses the reason for the visit and better defines the context in which the clinician can perform effectively.

■ Exploring the Current Job Situation

In addition to being a potential source of health risk, work is also a central and crucial component of life for most adults, encompassing both positive and negative aspects. On the positive side, work provides a sense of identity and self-worth, an organizing principle for time, the primary source of income, and a series of relationships, including those with superiors, colleagues, and those supervised. On the negative side, work also provides one of the most enduring of life's stresses, a distraction from family and friends and a source of alienation and self-doubt. Moreover, work is not necessarily constant in any of these features. Tasks and personnel fluctuate, responsibilities grow, and the economic picture is always subject to change, sometimes with minimal warning. Given this spectrum of roles that work may fulfill and its inherent variability, it is not surprising that factors related to work may be central to the diagnosis and management of patients. For the clinician, the following two important questions should always be answered:

1. To what extent are work factors (other than specific environmental health risks per se) modifying the timing and presentation of illness?

This question is central in several settings. An example is seen in the older worker who presents with a chronic or slowly progressive disorder, such as mild central nervous system, musculoskeletal, or respiratory dysfunction. Because these problems typically evolve over years, the timing of presentation may coincide with other disturbances or changes at work, such as increasing difficulty accomplishing former tasks (often with some attendant rebuke or discipline), threat of job security from younger workers, perceived obsolescence of the job itself, or the possibility of a plant closing or lay-off. Deeper concerns about the work situation also afflict displaced workers who have moved into unaccustomed jobs, as well as former housewives who have been pressed into the job market unexpectedly by economic needs.

Whatever the setting, correct diagnosis and treatment require that the clinician endeavor to understand the patient's conscious or not so conscious agenda for seeking attention. For older workers who are failing at their jobs, aggressive approaches at rehabilitation based solely on health considerations are likely to fail. Assistance with the often traumatic but appropriate transition to the next phase of life is probably more likely to meet the needs of patient and employer alike. For younger or transitional workers, early health concerns may be important signs of a constitutional mismatch between worker and job. In these instances, blind focus on treatment and return to work without consideration of larger issues may lead to costly and ineffective treatment options.

2. To what extent will work factors limit the range of options available for management of a work-related health problem?

The willingness and ability of patient and employer to accept medical recommendations that dictate any but the most temporary or trivial change in work depends on many factors unrelated to health. Often, the patient is well aware of these constraints and will explicitly discuss them with the physician, but frequently, they are couched only in terms of health, leading to denial or exaggeration of certain complaints according to the way they may translate into treatment recommendations. For example, if a patient is struggling with a particular supervisor, factors attributed to that supervisor or work area may be accentuated to the exclusion of other important environmental issues at the workplace. The best approach for the clinician to take is to attempt to elicit these non-health-related factors about the patient's job as early and as explicitly as possible. Such knowledge offers the best way to avoid confounding diagnostic issues by social factors and to focus management choices.

■ Exploring the Home and Family Situation

Although knowledge of family is crucial in the practice of medicine generally and is a normal part of the general history, home and family considerations have special importance in the practice of occupational and environmental medicine. Work may be a major family stressor because the demands of the individual's job compete against those of his or her family for time and energy. Often, the earliest effects of work-related illnesses, such as noise-induced hearing loss or central nervous system dysfunction due to metals, solvents, or pesticides may be first recognized because of their impact on family functioning rather than work functioning. Conversely, stresses within the family may result in changes in work performance, which, in turn, may enhance stresses on the job. Further, perception of risk may differ between those in the work environment, where certain hazards are seemingly accepted, and the family setting, where the possibility of illness or injury is deemed too threatening.

In environmental health, the family takes on a whole new dimension. Here, the home itself may be the focus of concern, because of a hazardous substance perceived to be in the air, walls and furnishings, or water supply. This threat to family health may have symbolic importance that in some cases exceeds health risk or impact. Not only is the home important symbolically, it is often the basis for the family's entire economic and social security. Persons are not easily moved from their homes, even under the most dire environmental threats. The prospect of reduced property values based on environmental risk also sharply heightens the sense of threat. The fact that levels of harm or risk in the home often are minuscule compared with those in the workplace must never translate into a lesser level of concern or attention paid by clinicians.

The Agenda of Third Parties

As noted above, OEM is unique among medical specialties in the high fraction of patient referrals initiated by nonphysicians, such as employers, insurance companies, and lawyers. Even when patients are referred by physicians, the underlying agendas of these outside parties often account for the referrals. Of course the interests of these parties, like the special interests of the patient and the family addressed above, do not alter the actual diagnosis or risk. However, like the agendas of the patient, the interests of these parties may serve to limit access to information or actually distort reality and could, unless they are recognized, interfere with the clinician's ability to make a correct diagnosis or risk assessment. Beyond the diagnostic stage, the interests of outside parties have an impact on the range of therapeutic choices, whatever the correct diagnosis. For all these reasons, the current or potential interest of each of the major third parties—including employers, lawyers, and insurance car-

riers—should be assessed as part of the evaluation of any significant occupational or environmental medical problem.

The Ethics of Occupational and Environmental Medicine Practice

In occupational and environmental medicine, relatively little attention has been given to ethical issues faced by physicians who provide health care to workers or to those with other environmental concerns or risks. Until now, the focus of the limited ethical debate has largely centered on occupational physicians employed by industry. This focus has neglected the important role of primary care physicians, who frequently face the same ethical dilemmas and are often the point of first contact with the patient. The following discussion identifies ethical issues to be considered by all providers, regardless of practice setting, recognizing that a dynamic legal and regulatory environment may introduce additional factors dictating appropriate responses in circumstances generated by physician-patient interactions (see Chapter 5).

Extent of the Problem

Ethical problems arise often for physicians who provide health services to workers, although many would argue that it is the frequency rather than the nature of the issues that distinguishes the practice of occupational (and to a lesser extent, environmental) medicine from other specialties. This perception is borne out by one systematic survey of a random sample of physicians in the United States who are members of a specialty physician organization. Among respondents, 69% identified ethical issues as arising in their practice—sometimes for 48%, frequently for 18%, and always for 3%. Patients are likely to assume that some physicians, particularly those employed on a full-time basis or otherwise contracted by industry, have split loyalties between the best interests of the individual patient and those of the employer. Professional organizations of physicians and other health professionals have recognized some of these conflicts by developing codes of ethical conduct. For example, the American Occupational Medicine Association Code of Ethical Conduct, developed in 1976, declares that the physician's primary allegiance is to the patient. The code opens with the statement, "Physicians should accord highest priority to the health and safety of the individual in the workplace. . . ."

Approach to Potential Ethical Dilemmas

The ethical principles derived from providing medical care of any type can be applied reasonably to the circumstances of providing health care to individuals with known or suspected occupational and environmental conditions. Some special circumstances, such as pre-employment and preplacement examinations, deserve unique consideration. The following section considers these principles as applied to six aspects of OEM practice.

Awareness About Occupational and Environmental Health

Physicians are understandably challenged and even intimidated when considering the rapidly changing and growing field of occupational and environmental medicine, and discerning strategies to incorporate relevant material into traditional clinical practice. Increasingly, the patient brings questions of environmental concern to the physician's attention. And physicians, although seen as trusted sources of information, have become identified by patients as generally not well informed about occupational and environmental health risks. Many factors have been identified as contributing to physicians' inadequate knowledge about and underinvolvement in the occupational and environmental health arena, including insufficient medical education, isolation of many of these services and payment for them from mainstream medical practice, and the increasingly complex array of potential exposures and known, let alone suspected, health effects arising from them.

Nonetheless, the physician in OEM, as in other areas of medicine, has an ethical obligation to be as informed as possible and, perhaps most importantly, to recognize when his or her own knowledge or experience is insufficient to resolve the problem and consultation is needed. In much the same way that a generalist might ask a cardiologist for assistance with a straightforward cardiac evaluation and treatment, physicians faced with potential occupational and environmental health problems that are beyond their own capabilities or resources should seek professionals with appropriate expertise. This minimum standard, maintaining awareness about occupational and environmental health risks or conditions, is a fundamental ethical principle and one that, at least in the United States, is likely to be accompanied by legal responsibility as well. Judicial opinion has held that the physician exploring a health problem that may have an occupational basis bears a responsibility to inquire fully into the work history of a patient.

The Physician-Patient Relationship

The physician-patient relationship is the foundation on which virtually all activities in clinical medicine rest. This relationship is frequently challenged in occupational and environmental medicine practice, but ethical and legal principles (which are further described in Chapter 5) common to general medical practice can be readily applied even to situations seemingly unique to this field.

■ Loyalty

Long a basic tenet of medical ethics in general, the primary loyalty of a physician is to the patient. Although there is evidence to substantiate the concern among workers that physicians employed by industry have not always followed this dictum, the issue of loyalty is by no means confined to the company physician. Physicians in all aspects of clinical practice may face the challenge of having payment and referral sources shape the nature of their interaction with the patient; pressure is sometimes explicit and often implicit to respond to competing needs. Whether the pressure arises from the health of the company or cost containment dictated by insurance carriers and managed care or preferred provider organizations, the required response may not always serve the patient's best interests.

Physicians providing occupational, and to a lesser extent, environmental health services must appreciate that although ideally both the patient's and company's (or third party's)

interests are best served by the same good medical practice and preventive interventions, these ends can and do at times come in conflict. In these difficult but not infrequent situations, the physician must rely on the primary ethical responsibility to serve patients first. This mandate is derived from the larger context of the physician-patient relationship, although a possible exception is the setting of preplacement examinations, which is discussed later in this section.

■ Confidentiality

The patient's right to confidentiality in all aspects of the physician-patient relationship is another basic principle of medical care. Perhaps more than in most areas of specialization, the disclosure of information about evaluation and treatment of known or suspected occupational or environmental conditions has the potential to cause serious harm to the individual and may affect the individual's employment security. Although recent regulatory efforts in the United States and elsewhere have tried to ensure that information obtained from medical records not be used to block hiring or continued employment, the information can still be seriously damaging. In caring for individuals with occupational and environmental conditions, once a doctor-patient relationship is formed, the usual rules of confidentiality should apply.

Confidentiality refers to both the written and verbal release of information. Medical records should be maintained to optimize protection; patients should sign a release form for any information that is to be disclosed to a third party (and he or she should have a reasonable understanding of the implications of doing so), and no record should be released to a third party unless the patient has signed a release form. Patients should be informed of situations in which confidentiality cannot be protected. For example, once a workers' compensation claim is filed, confidentiality can no longer be protected in reference to information relating to that claim because the employer and appropriate agencies have legal access to it. Medical records can be subpoenaed, as will often happen if the patient becomes involved in litigation such as third-party liability. Another example in which confidentiality cannot be protected, not because of ethical but because of legal reasons that dominate the process, is military employees in the United States, whose medical files are accessible to their superiors.

The over-riding ethical obligation to maintain patient confidentiality is not absolute, and there are situations other than those legally mandated in which it may be more appropriate to reveal than withhold information that the patient wishes to be kept confidential. Such decisions to violate confidentiality undoubtedly should be rare and need serious consideration on a case-by-case basis. In addition, the circumstances in which they may arise are not unique to occupational and environmental medicine. They fall in two general categories: either in the patient's best interests or because of an over-riding duty to protect the public health (such as notification of contacts in venereal disease cases). What arises more commonly in occupational medical practice than in virtually all other fields is that the detection of disease or hazardous exposures in one person may point to the probability that the same problem may arise with other co-workers, household members, and community residents. In instances in which concern about others is sufficiently high, consideration must be given to the serious step of breaching confidentiality.

Patient Advocacy and Conflicts of Interest

Physicians who provide occupational or environmental medicine services, particularly those who do so in the context of a broader general practice, may face the challenge of making objective decisions about patient illnesses and employability when they have a personal, emotional, and even financial interest in these patients and their families. This potential conflict, of course, is not unique to the occupational or environmental health arena; society relies on physicians to undertake a number of activities that are aimed primarily at societal welfare rather than the benefit of individual patients or their families. Included in these activities are physical examinations for insurance, sports participation, or disability purposes. Here, it is either the public at large or some subset, including special interest groups, who ask the physician to make judgments that may differ from an individual patient's desires or interests. The physician usually can decline to perform such evaluations; however, this approach is not always possible and, if chosen, does not necessarily result in resolving equitably the situation at hand. The best approach to use in cases in which patient advocacy may conflict with the physician's objectively performing an appropriate and reasonably requested function is to apply ethical principles of loyalty and confidentiality and to inform the patient fully of explicit and implicit uses of such information. The specific circumstances of medical screening that may stress the physician-patient relationship either for or against advocacy are described in a later section.

Disclosure to Patients

Another fundamental aspect of the physician-patient relationship is informing patients fully about their conditions, including reasons for and against various diagnostic and therapeutic strategies. In conditions related to occupational or environmental factors, this requires full discussion about the implications of undertaking evaluations, including legal or other constraints on protecting confidentiality, and the implications of treatment interventions. The last-mentioned issue is particularly important given the major impact of therapeutic choices that include job or home modification or relocation so that the individual can avoid continued hazardous exposure. The physician has a responsibility to discuss the range of reasonable choices, acknowledging that the optimal medical choice may be forsaken for one less ideal because of the social, economic, or legal ramifications. Included in the ethical responsibilities of disclosure are providing information and participating as dictated by local custom and regulations in the workers' compensation process.

Reporting to Third Parties

In addition to disclosing information about environmental risks to the patient, the physician has an ethical and occasionally legally mandated responsibility to consider which third parties (e.g., employers, agencies, unions) would benefit from information derived from the physician-patient relationship. The potential for prevention by undertaking this follow-up of suspected or known occupational or environmental diseases or risks is one of the most satisfying aspects of

clinical practice in this field. In the United States, legal responsibilities to report these conditions vary considerably from state to state; however, independent from legal mandates, physicians should identify the most appropriate means to report these risks or conditions. Examples of reporting include notifying local or state health departments, regulatory agencies, employees, and unions; publishing in scientific journals; and informing the public through the media. Which, if any, of these avenues should be pursued depends on numerous factors, including the seriousness of the risk and the likelihood of undetected occurrence in others. Unless there are extraordinary reasons to do otherwise, all actions should be taken in light of the promise of confidentiality inherent in the physician-patient relationship. The following section is a brief overview of those parties the physician should consider contacting in dealing with cases of known or suspected occupational and environmental diseases or hazards.

■ Employer

After a thorough discussion with the patient about the implications of doing so, the employer, whenever feasible, should be informed about workplace hazards or conditions. The employer is in the best position to undertake preventive action and further environmental or medical assessment as needed. In addition, the employer may be able to provide the physician with additional data on the nature and intensity of exposures that will enhance clinical evaluation of the patient.

■ Union

Unions vary in the extent to which they become involved in workplace health and safety issues. They may provide additional sources of exposure information and may directly or indirectly identify other co-workers who may also be at risk. They also may be well positioned to optimize the likelihood of appropriate interventions. As with contact with other third parties, the patient should first consent before problems are reported to the union.

■ Health Agencies and Referral Centers

Local, regional, and national health agencies play variable roles in occupational or environmental health issues. In some settings, the health agency may be the best place to report initially a known or suspected hazard, with subsequent appropriate follow-up then assured from this single point of contact. In other instances, specialty referral centers, such as those affiliated with academic medical centers and hospitals, are best equipped to follow up the results of an individual evaluation. In the United States, the National Institute for Occupational Safety and Health (NIOSH), in addition to its training and research functions, provides consultation services about hazardous workplaces, a function also provided by some state and local health departments.

■ Regulatory Agencies

A number of regulatory agencies, including in the both state and federal Occupational Safety and Health Administration (OSHA) plans in the United States, can provide assistance to the physician and be important agencies to which to report occupational hazards or conditions. One preferred response that may be available is for OSHA or its equivalent to provide, on employer request, consultation about workplace hazards without any threat of fines. In the United States, if circumstances warrant and after confidentiality considerations have been reviewed, a physician may file a complaint about a workplace hazard, which, in turn, should generate a workplace inspection. Although such complaints can be made anonymously, the physician should appreciate and advise the patient that the nature of the complaint may result in identification of that person and possible subsequent harm. Similarly, agencies that are involved in control of the nonworkplace environment, such as the federal Environmental Protection Agency (EPA) and related state and local agencies in the United States, may be contacted. In both occupational or other environmental settings, these agencies also may have valuable information about exposures and results of past investigations or monitoring that may aid the physician in making a clinical assessment.

The Physician's Role In Medical Screening of Workers

The physician faces a number of scientific and ethical challenges in undertaking medical screening in general (see also Chapter 3). These challenges may be heightened when the patient is a worker undergoing mandated or voluntary examinations. The nature and legal restraints of such examinations have recently undergone significant change in the United States with the passage of the Americans with Disabilities Act (ADA; see also Chapter 5). Dilemmas arising from the performance of these examinations are often the result of contradictory expectations and objectives. Ideally, such examinations should provide early detection and the means to prevent injury or risks and to optimize the match between job exposures and demands as well as individual capabilities and health status. However, often this is not the case—risks and benefits of screening may not be shared equally by employee and employer. The physician may experience a conflict between the roles of patient advocate and social gatekeeper. Nonetheless, keeping in mind the previously described ethical and medicolegal principles, the following section provides guidelines for physicians who perform preplacement and periodic examinations.

The ADA in the United States has clarified some of the legal and medical controversy surrounding preplacement examinations, that is, those examinations performed prior to beginning employment. Although some uncertainty remains, examinations of this type generally are restricted to jobs in which unique occupational qualifications are required (e.g., physical fitness criteria for firefighters) and medical information will be curtailed to include only that relevant to performing specific duties. The goal of this legislation is to limit discrimination in hiring and retention based on medical conditions, regardless of occupational origin. Nonetheless, because some forms of pre-employment or preplacement examination will continue, some general principles may be followed in order to perform these examinations with the highest ethical and scientific standards.

The premise that the patient willingly enters the physician-patient relationship in these settings is not applicable—legal opinion usually exempts these interactions that are employer driven and mandated from the usual physician-patient relationship. The following four guidelines should be used by physicians:

1. Determine whether the screening program is medically sound. Using the same characteristics that are applicable to other types of medical screening, those done for placement or similar examinations (including periodic examinations for those already employed in specific jobs) should be reliable, valid, and have high predictive values. For example, low back x-ray studies have not proved to be predictive of those who will become disabled from work-related back injury; physicians should decline to perform these and other faulty screening tests.

2. Ensure that only appropriate information about the results of medical testing are released. Although, legally, the confidentiality inherent in the physician-patient relationship may not be protected in these examinations, ethical principles still dictate confidentiality of at least some aspects. The employer has a reasonable right to information about whether or not an individual can safely and capably perform a given job but not to specific information about the individual's medical conditions. The American Occupational Medical Association's Code of Ethical Conduct explicitly supports this premise. Following is an example of one approach to supplying this information:

On the basis of our medical evaluation, the above-named person is medically

- Able to fully participate in the work described.
- Not able to fully participate in the work described.
- Able, with the following job modifications, to undertake the work described.

3. Ensure that enough is known about the job requirements so that reasonable determinations about the employability of the individual can be made. Part of this process involves an appreciation that employers have a responsibility to provide a healthy workplace, and that examinations should not substitute for available interventions by selecting only those few seemingly able to tolerate unhealthy work.

4. Discuss with the patient and the employer prior to performing the examination the content of the evaluation, the implications of potential findings, and how and what information will be released. Full advance discussion helps avoid subsequent debate from either the employer or the employee. Although there may be no clearly established legal physician-patient relationship, there remains an ethical obligation for physicians to discuss with patients identified hazardous exposures or medical conditions, including referral for further evaluation and treatment when indicated. Moreover, for physicians who provide periodic examinations for individuals who are already employed (whether legally or employer mandated), it is appropriate that physicians be assured by employers that employees identified as unable to continue in their current jobs safely are relocated, with adequate efforts made for wage and benefit retention. As in all other evaluations, if work-related health conditions are identified in the course of screening examinations, the physician has an ethical, if not legal, responsibility to undertake appropriate interventions and follow-up.

ECONOMIC, ETHICAL, LEGAL, AND SOCIAL FACTORS IN PATIENT EVALUATION

There are four conceptual steps in the management of patients suspected of occupational or environmental disease. Although actual treatment choices depend on the particular hazardous exposure, clinical disorder, and relevant social issues, the conceptual framework remains uniform.

The Diagnostic Period

In every case, there is a period of time from the first contact with the patient until the best possible working diagnosis can be achieved. Although this period may be as short as a single visit in cases of clear-cut exposure and a well-delineated physiologic response (or its absence), often this period spans days to weeks and occasionally even longer, during which relevant records of medical and exposure history are obtained, environments evaluated, and additional tests performed. Several important aspects of management should be kept in mind during this period.

1. Formulate the diagnostic plan at the outset. For reasons already given, it is apparent that many potentially knowable facts may remain unlearned. Therefore, at the outset, it is important to decide how the diagnostic process will proceed, whether or not one succeeds in obtaining additional desired information.

2. Use the diagnostic period to the fullest. An advantage of small delays in achieving best clinical diagnosis is that it facilitates ascertainment of various social issues discussed previously, such as the agendas of all parties and likelihood of reactions if certain choices are proposed.

3. Do not initiate management decisions until the best diagnosis is achieved. Although a few occupational and environmental illnesses are identified as medical emergencies, the vast majority are not. Many facts, such as the temporal relationship between physiologic responses and exposures or the measurement of biologic exposure doses, are best learned while a patient remains in an exposed situation. Further, given the great ramifications of certain courses of action, such as removal of a worker from a job or the designation of a particular health problem as occupational, it is important not to take such steps prematurely when there is a reasonable likelihood that subsequent facts may change the diagnostic thinking and subsequent plan. Although further exposure may seem to place a patient at unnecessary additional risk, it is important to place that risk in the context of exposures that have already occurred and the very real risk of taking steps that may be harmful in themselves, especially if they are premature and wrong.

In certain circumstances, diagnosis itself depends on the individual's response to a therapeutic trial, such as whether or not the symptoms abate on removal of the individual from an environment. Although such trials are sometimes necessary or desirable, they should be conducted as trials, with the explicit understanding that the goal is to establish a diagnosis and not to constitute treatment based on a particular diagnosis. Only in this way can future confusion be avoided and, with it, the attendant social costs to the patient.

Formulation of Treatment Plans

Once the diagnosis has become sufficiently clear, treatment plans can be developed. Often the choice is strongly dictated by clinical circumstances, as in cases of disabling chronic

diseases. More often, however, there are alternatives. Although one choice or another may seem preferable from a strictly medical perspective, it cannot be presumed that this choice satisfies the needs of the patient, or that it is included among the options offered by the employer or other relevant parties. Whenever possible, it is appropriate to consider alternative possibilities for the management of every case. On some occasions, medical realities point clearly to only one course of action, such as discontinuing exposure of a patient with heavy metal or pesticide poisoning.

Establishing and Communicating the Therapeutic Plan

However limited or diverse the options considered, the actual choice of a treatment plan cannot be made without discussion with the parties who must participate, first and most importantly the patient. The benefits, costs, and health risks associated with each option must be identified so the patient can make an intelligent decision based on all the facts. If necessary, he or she should be encouraged to include a spouse or other family member who may be affected by the choice. Advice from other advocates, such as a social worker or a union representative, may be invaluable, especially when one choice or another may disrupt the individual's normal life activities, work, or income.

Once the patient has agreed to a plan, it is reasonable to communicate that plan to the other parties who must cooperate, especially in the occupational setting. In every case, the patient should be aware of the planned communication and it should be limited to issues that are within the purview of the doctor's relationship with nonmedical parties. Once an approach has been selected, it is important that results of the evaluation be put in writing for the patient, his or her doctor, and others who need to have this information. Dissemination of this information can often be best accomplished by a single letter, which is sent to everyone. Although this method may limit communication of certain private issues and require use of language not technically ideal for every reader, the use of a single letter reduces the likelihood of anyone misunderstanding what has been found and recommended.

Therapeutic Follow-Up

Whatever plan is chosen, clinical and nonclinical consequences that arise during the initiation of the plan may lead to reconsideration by patient, physician, or both. For example, the impact of altered life circumstances, such as joblessness, may provoke re-evaluation of options however strongly they are indicated from a clinical perspective.

By planning visits for no grander purpose than a progress update and plan re-evaluation, the physician offers the most flexible and supportive milieu in which the patient can accommodate to changes demanded in the management of occupational and environmental health problems.

Where Does the Physician's Responsibility End?

One of the most inescapable realities of modern OEM practice in most parts of the world, including the United States, is that many hazardous situations will be recognized about which little can be done. Reasons include limitations of resources available in the professional community, corporate sector, and governmental agencies; technical uncertainty about the solution of certain problems; economic incentives to ignore or resist recognition and solution of environmental problems; inadequate regulatory and administrative structures to evaluate and resolve environmental hazards; and last, but not least, widespread ignorance.

None of these factors should form the basis for physician apathy or reluctance of the physician to consider and act on the public health implications of a serious occupational or environmental disease or injury. At a minimum, the record should clearly indicate the physician's opinion that others may be at risk. The choice of strategy should be well documented in the patient's record. Finally, although various approaches may best be carried out verbally or informally, in the end it is important that individuals or companies that control the environment in question be formally notified that concern has been raised. This notification may come directly from the physician or, more often, indirectly though an agency or consultant. Ideally, the physician's effort should be documented in writing, which is far more effective in motivating action than informal approaches.

Once these steps have been taken, the practitioner can and should return to the care and needs of the patient, whose OEM problems and their clinical and social sequelae may take months and, often, years to resolve. This is the same timetable that public intervention may follow. Clinicians may choose early in the process of public health actions to turn responsibility over to others; regardless, the often delayed but sometimes highly effective link between clinical evaluation and resultant greater public health good is one of the great satisfactions in OEM practice.

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