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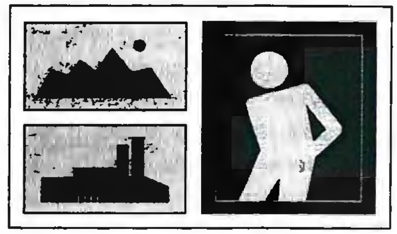

CHAPTER 2

Recognition and Evaluation of Occupational and Environmental Health Problems

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Most occupational and environmental diseases present as common medical problems or have nonspecific symptoms. Indeed, it is the etiology, rather than the pathology, that generally distinguishes disorders as occupational or environmental illnesses. It has been estimated that the workplace attribution for over 60% of occupational diseases may be unrecognized (1). Thus, clinicians must maintain a high index of suspicion for disorders that may indeed have an occupational or environmental cause. A brief occupational and environmental history should be part of every medical history. In recognition of this need, the Healthy People 2000 goals for Occupational Safety and Health (2) include the following: "Increase to at least 75% the proportion of primary care providers who routinely elicit occupational health exposures as part of the patient history and provide relevant counsel." The occupational medicine literature contains numerous references to the so-called astute clinicians who first made the connections between occupational exposures and specific disease entities (3). These range from the historical descriptions of scrotal cancer in chimney sweeps to more recent descriptions of angiosarcomas of the liver from vinyl chloride and male infertility associated with dibromochloropropane.

Early diagnosis and proper management can improve outcomes for many occupational and environmental diseases. For example, the duration of exposure after the development of symptoms is a significant predictor of long-term outcome in occupational asthma (4). Recognition of an occupational disease in an individual may serve as a sentinel health event indicating a public health need for intervention to prevent disease in other exposed workers (5). While clinical recognition and evaluation of the contribution of workplace and environmental exposures to morbidity and mortality are mainstays of the specialty of occupational medicine, all physicians should be alert to these conditions in their patients. Extensive knowledge of toxicology is not needed for the evaluation of most occupational and environmental disorders. As in general medicine, the history is the most important aspect of making a diagnosis and is complemented by the findings of the physical examination. Chapter 4 provides a detailed discussion of the occupational and environmental history and physical examination. Laboratory tests and other diagnostic modalities can help confirm suspicions suggested by the history or physical findings.

DIAGNOSTIC MODALITIES

Levels of many substances or their metabolites are directly measurable in blood or urine. These tests may be used in ongoing biologic monitoring programs, or as part of the diagnostic evaluation in the workup of a single worker or a small group of workers (6). Lead and benzene are the two most common substances for which employers provide ongoing biologic monitoring as part of medical surveillance programs (7). Published references summarize the medical tests recommended by the United States federal government and independent researchers for sub-

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stances regulated by the Occupational Safety and Health Administration (OSHA) (8). The sampling time for biologic monitoring may be very critical and must be adhered to, particularly when the levels of the determinant change rapidly or accumulation occurs because of continued exposure to the chemical. If the worker has been unexposed for a significant period of time, the detectable body burden may be low despite the existence of adverse health effects. The physician should keep in mind that results from biologic sampling are reflective of exposure and not direct measures of adverse health effects. There may be considerable variation in the observed effects from a given exposure; persons who have idiosyncratic responses due to sensitization, coexisting conditions, or other intrinsic characteristics may suffer adverse effects from exposures that are generally considered safe.

In medical surveillance settings, audiometric examinations are the most commonly employed testing modality (7). Chest radiographs, preferably classified by the International Labor Organization (ILO) system (9), pulmonary function testing, serial peak flow measurements, and carbon monoxide diffusing capacity are common tools for evaluating pulmonary abnormalities (10). Surveillance end points have been proposed for hepatotoxins (11), nephrotoxins (12), neurologic disorders (13), occupational cancers (14), and infectious diseases (15).

EVALUATION OF THE WORK SITE

Occupational medicine physicians frequently are asked to participate in work-site evaluations. These evaluations may be performed to determine the work-relatedness of a

TABLE 1. *An approach to the collection of health-related data*

Establishing a case definition and confirming cases:
1. Is there a sentinel case or a cluster of reported illnesses?
2. Is there a syndrome-like consistency to the reported symptoms and signs?
3. Have examining physicians confirmed the cases?
4. Are reproductive or "take-home" familial effects recognized or plausible?
5. Once cases are confirmed, can the reported clinical syndrome or case definition be explained by a biologically plausible hypothesis (differential diagnosis), e.g., exposure to chemical, physical, or infectious agents?

Case finding and descriptive epidemiology:
1. Who and how many are ill? (numerator)
2. Who and how many are exposed or at risk? (denominator)
3. Can you estimate the prevalence or attack ratio? (numerator/denominator)
4. Is there evidence of urgency because of the severity, extent, or progression of symptoms?
5. Is there evidence of a unique or high-risk group of affected persons (response by job types, job locations, or tenure at work)?
6. Is there a temporal or spatial pattern to the onset of the problems among individuals or within job categories? Do symptoms vary with process changes, shift changes, weekends, shutdown, or transfer from one job to another?
7. What are the predictive value, sensitivity, and specificity of screening tests available for case identification and case confirmation?
8. Can you characterize the affected or exposed populations by a line listing of name, age, zip code, sex, ethnicity, job classification, date of hire, time in current job, and date and circumstances of onset of symptoms, if any? When available, list previous occupations, smoking history, and other known risk factors.
9. Is there a relevant preemployment medical database? Are routine periodic follow-up examinations performed? Are the compensation, medical, and life insurance records accessible and organized to include information on the employees occupational and medical histories, as well as specific diagnoses?

Analytical epidemiology:
1. Is there an appropriate nearby occupational group available for comparison studies?
2. Does the company, Centers for Disease Control or NIOSH, state health department, federal or state regulatory agency, or a nearby medical center have epidemiologic data on relevant exposures, morbidity, and mortality patterns in the work site and the local community (i.e., the expected values)?
3. If subacute or chronic disease is suspected, can former employees be located and their vital status ascertained? Can the cause of death be ascertained for deceased former employees? Are there historical environmental monitoring records available for former and present employee exposures by job category?
4. Considering the expected distribution and occurrence of similar disease entities that may be attributable to infectious, immune, congenital, vascular, metabolic, neoplastic, degenerative, or psychosocial processes, can you account for any excess of disease by a plausible association with prevalent or historical occupational exposures?
5. Do the size of the population at risk and an available comparison group permit reliable detection of a true excess of disease?

TABLE 2. *An approach to the collection of environment-related or work site hazard data*

1. Can you describe the industrial process (or processes) and physical plant, including the nature and adequacy of industrial hygiene control technology (local and general ventilation, etc.)?
2. Are the problems isolated within the workplace by location or job types?
3. Are agents present that are known or suspected to cause the alleged acute, subacute, or chronic health problems?
4. What is the physical form of these agents? By what route or routes of entry are workers exposed?
5. Are there industrial processes for which the composition, exposures, and toxicity of products and by-products are inadequately characterized?
6. Have there recently been changes in the raw materials, maintenance, or operation of industrial processes? Be sure to consider lubricants, additives, solvents, contaminants, products, and by-products, as well as the major industrial agents or processes. Obtain material safety data sheets for suspected agents and the results of bulk analyses for the identification of trace contaminants.
7. If the problems have been chronic, why is the request being made now?
8. What is known about the compliance history and environmental monitoring results of the workplace environment with respect to known agents and established standards?
9. Are labor-management or workers' compensation disputes involved in the request?

single patient's symptoms, to investigate allegations of adverse health effects in a group of workers, to assist in the design of health and safety programs for a facility, or as a work-site "follow-back" study of a sentinel health event (Table 1). These workplace evaluations can range from brief walk-through surveys to more in-depth investigations including medical and environmental testing. The general evaluation format presented here follows that used by National Institute for Occupational Safety and Health (NIOSH) investigators in the Health Hazard Evaluation (HHE) program. The NIOSH teams usually consist of a medical officer and an industrial hygiene professional working together to perform a comprehensive evaluation of occupational hazards in a workplace (Table 2).

Consultants conducting work-site evaluations should gather as much information as possible about the establishment before the site visit. Frequently this begins with a literature search centered around the materials and processes used. The NIOSHTIC database (Table 3) contains citations from the occupational safety and health literature as well as NIOSH reports. It is useful both as a reference source and to determine whether NIOSH has conducted an HHE at this or similar facilities. Other useful electronic databases include MEDLINE (Table 3), a good general medical database, and TOXLINE (Table 3), which is a fairly specific toxicology database. The Registry of Toxic Effects of Chemical Substances (RTECS) (Table 3) is a specialty database, produced by NIOSH, that contains data on toxicity, irritation, mutagenicity, reproductive effects, U.S. government standards for occupational exposure, and other data on more than 100,000 chemical substances. The increasing availability of scientific databases via Internet and World Wide Web technologies makes this information accessible even to occupational health professionals who have limited access to university or government research settings.

All work-site evaluations should begin with an opening conference led by the occupational health consultant. Attendees should include the plant manager, an individual responsible for plant health and safety, and at least one worker representative. This meeting should define the scope and nature of the investigation, address methods of environmental and medical testing, and clarify concerns about trade secret and medical confidentiality issues. All attendees should be given the opportunity to ask questions or express concerns about the investigation process.

Once the opening conference is complete, the consultant team should devote some time to reviewing company health and safety records before actually beginning the walk-through. OSHA 200 logs can provide a good source of information about company injury and illness incidence rates, but company record-keeping practices, including who has responsibility for log maintenance, may result in considerable variability in reporting between firms or from year to year. Logs from a company nurse, physician, or first-aid center may give additional information about injuries and illnesses that were not considered reportable. The company's hazard communication program should be reviewed. A material safety data sheet (MSDS) should be available for each toxic material used in a workplace (16); review of this information can identify many potential occupational hazards. Even a comprehensive set of MSDSs may not reflect all chemical hazards in the workplace since reactive intermediates in the manufacturing process will not be reflected in this information. For example, the 1984 Bhopal disaster in India involved the release of methyl isocyanate, an intermediate in the production process of manufacturing the insecticide carbaryl.

Industrial hygiene data collected by the company or outside consultants should be reviewed. Ideally, personal sampling data are available for a representative number of employees throughout the plant and have been correlated with appropriate medical or biologic monitoring data. In reality, environmental monitoring data may be limited to area samples or to personal samples on a small number of workers. Individual work practices vary enough that two

TABLE 3. *Sources of access to the occupational health information*

Most hospitals offer some form of access to the MEDLINE and TOXLINE databases. Hospital librarians usually are quite skilled at searching these databases. They can also assist in locating journal articles and documents identified from literature searches.

For persons who wish to perform their own literature searches and who have basic microcomputer equipment and modem, direct access is available to MEDLINE, TOXLINE, NIOSHTIC, RTECS, and other databases.

Direct access to the MEDLINE and TOXLINE files of the National Library of Medicine can be arranged by contacting:

MEDLARS Management Section
National Library of Medicine
8600 Rockville Pike
Bethesda, MD 20894
Telephone: (800) 272-4787; (301) 496-6193
FAX Number: (301) 496-0822
E-mail: PUBLICINFO@NLM.NIH.GOV

Access the NLM Home Page on the World Wide Web at:
http://nlm.nih.gov

NIOSHTIC and RTECS and other on-line databases are available through private vendors. The list is available from the NIOSH Publications Dissemination office (see address below).

For assistance with obtaining NIOSH publications, contact the following office:

National Institute for Occupational Safety and Health
Publications Dissemination
4676 Columbia Parkway
Cincinnati, OH 45226-1998
Telephone: (800) 356-4674; (513) 533-8287
FAX Number: (513) 533-8573
E-mail: PUBSTAFT

Access the NIOSH Home Page on the World Wide Web at:
http://www.cdc.gov/niosh/homepage.html

To request a NIOSH Health Hazard Evaluation, contact:

Division of Surveillance, Hazard Evaluations, and Field Studies
National Institute for Occupational Safety and Health
Alice Hamilton Laboratory
5555 Ridge Avenue
Cincinnati, OH 45213
Telephone: (800) 356-4674; (513) 841-4428

For assistance with obtaining OSHA publications, contact the following office:

U.S. Department of Labor
Occupational Safety and Health Administration
Publications Office, Room N-3101
200 Constitution Avenue, N.W.
Washington, DC 20210
Telephone: (202) 523-9667

workers doing the same job in nearly identical settings may have quite different exposures. The use of personal protective equipment may also modify individual exposures, although this is difficult to quantify. Workers may be using personal protective equipment without appropriate environmental data to demonstrate a need for it or to assist in appropriate selection. For example, many small firms require hearing protection in areas that are perceived as "noisy," but have never conducted noise surveys. As a result, individuals who should be included in a hearing conservation program may not be, and individuals who work in noisy areas, especially those exposed to impact noise, may be inadequately protected. Similarly, the choice of appropriate respiratory protection also depends on adequate knowledge of the nature and level of air contaminants in the work environment (17).

When permitted, the occupational medical consultant should review any medical surveillance data collected through company programs. This may be difficult to access or look at systematically since a great percentage of occupational medical services are performed by outside clinics rather than in company facilities. Companies may allow consulting physicians to review medical records that their employees have submitted in support of workers' compensation claims. If the consultation is being conducted in response to employee complaints, individuals who have sought medical consultation relating to the occupational conditions under investigation may voluntarily submit copies of their medical records for review.

In addition to the aforementioned medical and environmental information, the database for occupational health and safety consultations should be expanded to include information on company history, the formal statement of company goals, the actual working goals, formal and informal organizational structure, labor-management relations, and regional economic trends (18). For example, one manufacturer noted a sharp upturn in workplace injuries despite continued efforts to improve their safety program. On further review, it was found that the plant had a 50% annual turnover rate, which made it difficult to implement and sustain safety training. The high turnover was attributed to low local unemployment, the plant's requirement of shift rotation while competing employers had fixed shifts, and a wage scale that was on the low end for the area. High worker turnover and high production demands due to product popularity contributed to a high injury rate, despite stated company safety goals.

The walk-through evaluation itself is best accomplished by following the process from the entry of raw materials into the plant until the point where the finished product leaves the facility. This format should allow the consultant to see most job categories and departments and most routine job tasks. Maintenance activities and "rework" of substandard product should be evaluated as well. Tasks that are performed infrequently or are not viewed as an integral part of the production process are often given little attention in company health and safety activities until they are associated with an injury or illness. The use of personal protective equipment in prescribed areas should be observed, as well as employee hygiene practices such as eating, drinking, or smoking in potentially contaminated areas. The physician should keep in mind that exposure may occur through inhalation, ingestion, dermal absorption, or a combination thereof, and should look for evidence of these as the walk-through is conducted.

During the walk-through, it is useful to ask employees about their work. Individual workers can often provide more insight into their specific job task than the plant representative present on the walk-through. Discussions regarding health problems should be brief, informal, and confidential. Initial questions should be open-ended, rather than directed at specific symptoms or complaints. These can be followed with more specific questions about the nature, duration, timing and frequency of symptoms, as well as their association with work activities. It is also helpful to ask workers whether they know of any individuals who left employment with this company for health-related reasons.

If an industrial hygiene consultant is present, the walk-through survey may provide an opportunity for some limited environmental monitoring to help identify workplace contaminants and potential sources or exposure areas in the plant. Direct reading sampling equipment is available to assess airborne chemical contaminants such as carbon monoxide, oxides of nitrogen, acid gases, and combustible hydrocarbons (19). Smoke tubes are a convenient means of observing airflow patterns relating to plant operations or ventilation systems; velocity meters can be used to obtain more exact information on plant ventilation (20).

The findings from the walk-through survey will suggest whether a potential occupational health hazard exists, and whether an in-depth medical or environmental survey, or both, is needed to characterize it. If environmental data demonstrates significant potential exposures, the industrial hygiene consultant may recommend either a thorough one-time survey or an ongoing monitoring program. Ongoing monitoring is particularly useful for exposures to agents whose health effects include long periods with asymptomatic changes and conditions that may benefit from early detection (21). Design of an in-depth medical survey should be based on findings from the walk-through and knowledge about the expected adverse health effects of substances used in the workplace. Outside consultants will usually be limited to conducting cross-sectional studies, with their inherent limitations of measuring disease prevalence rather than incidence and inability to establish a temporal relation between exposure and disease. Other study methodologies, such as cohort and case-control designs may be more appropriate for investigating certain conditions; epidemiologic texts discuss the use and limitations of these study designs (22).

In addition to the technical and scientific skills required for workplace evaluations, health and safety consultants need to develop an understanding of how business and management practices contribute to the occurrence of work-related injury and inhibit adoption and implementation of health and safety recommendations (18). As an example, several employees at a large beverage manufacturer sustained back injuries performing a task known as "repalletization," which involved dismantling finished pallets of product and creating new pallets composed of a mixture of product lines. This task was necessary because the sales force sold the product in case units but the plant had an automated system that produced pallet units. The ergonomics consultant who was asked to reengineer the repalletization task suggested the administrative action of changing sales units to pallets, rather than trying to ergonomically correct an unnecessary task.

When the work-site evaluation is complete, whether after the walk-through or following a more in-depth survey, a report should be issued that summarizes the findings of the investigation and makes appropriate recommendations for continuing health and safety activities within the establishment. For example, the industrial hygienist might recommend appropriate control technology or an ongoing environmental monitoring program. The occupational health physician may recommend, and help the company design, an ongoing medical surveillance program using appropriate screening tests to look for end-organ effects associated with the hazards encountered in the workplace (23). An understanding of the firm's organizational structure is critical to the consultants' ability to bring about change. The consultant must identify and have access to someone with enough authority to facilitate the acceptance and implementation of the final recommendations (18).

CASE STUDIES

The following cases illustrate the importance of considering an occupational or environmental etiology in evaluating an individual patient, the need for a timely diagnosis, and the concept of an occupational illness in one worker being a sentinel health event suggesting that other workers are at risk.

Case Study 1

A 41-year-old man with no underlying respiratory problems worked as a maintenance man at a company that used an isocyanate-based polyurethane foam in its products. While working directly with the foaming process, he developed headache, fever, joint pain, dry cough, and shortness of breath. When symptoms worsened, he was taken to the local emergency room, and subsequently admitted to the intensive care unit. No connection was made between his illness and his work; his discharge diagnosis was viral pneumonitis.

He returned to work 2 weeks later, and worked with the polyurethane foam system. Respiratory symptoms developed again, and he was readmitted to the hospital later that day. Discharge diagnoses were bronchitis due to an industrial toxin and pneumonitis due to exposure to industrial toxin.

On returning to work after this second episode, the worker began to note a strong temporal relationship between his proximity to the foaming process and his respiratory symptoms. Three months after his initial illness, he consulted a local pulmonologist who diagnosed his clinical presentation as being consistent with hypersensitivity pneumonitis due to isocyanates. Pulmonary function testing revealed severe restriction with a moderate diffusion defect and mild obstruction. On the advice of the pulmonologist, the worker terminated his employment at that establishment due to inability to avoid exposure to isocyanates.

Two months later this patient was placed on oral steroids. After 2 weeks he developed an acute febrile illness and died. An autopsy revealed bilateral acute bacterial pneumonia and chronic interstitial pneumonitis (24,25).

Delay in recognizing the work-relatedness of the patient's condition resulted in repeated exposure with subsequent morbidity and mortality.

Case Study 2

A state health department responded to a physician's report of the death of a 55-year-old worker with accelerated silicosis and associated *Mycobacterium kansasii* infection. The man had been a sandblaster for 10 years, most recently in a metal preparation shop.

A work-site evaluation was conducted and revealed that although sandblasters were wearing respiratory protection, it was inadequate to protect them against the very high levels of respirable crystalline silica found in the workplace. Workers reported that coworkers had developed problems while working as sandblasters and that the employer typically hired six to seven new sandblasters each year to replace those who quit. One current worker was identified with severe silicosis, including progressive massive fibrosis, and several workers were found to have simple silicosis. Air sampling outside the blasting room indicated poor containment of the dust, potentially exposing other workers (26).

This case illustrates how a sentinel occupational health event led to investigation of a workplace where an ongoing hazard existed. This also demonstrates the incorporation of medical and environmental testing in a work-site evaluation.

Case Study 3

A 52-year-old nonsmoking male landscape architect presented to the emergency room with a 6-hour history of dyspnea, fever, headache, and myalgia. Twelve hours prior to presentation he had shoveled composted wood chips and leaves. Examination showed a patient in moderate respiratory distress, with a respiratory rate of 30, heart rate of 120, and an oral temperature of 38.8°C. Lung auscultation revealed fine bibasilar crackles without wheezing. Chest radiographs demonstrated bilateral infiltrates. Arterial PO_2 was 53 mm Hg. Systemic steroid therapy and antibiotics were started. A working diagnosis of pneumonia versus hypersensitivity pneumonitis was proposed.

The pulmonary infiltrates and hypoxemia worsened during the next 12 hours, but then improved over the subsequent 3 days. Pulmonary function testing the morning after admission revealed mild restriction (forced vital capacity (FVC) 68% of predicted). The symptoms and infiltrates improved, and the patient was discharged on the third hospital day. One month later he had no respiratory symptoms, and spirometry and diffusing capacity were normal.

Environmental studies revealed that the compost was a suitable substrate for the growth of many fungi and bacteria and measured significant levels of inspirable and respirable dust. These findings supported the clinical diagnosis of organic dust toxic syndrome (ODTS) (27,28).

This case illustrates how nonspecific symptoms may be attributed to common illnesses unless an occupational etiology is sought.

Case Study 4

A 44-year-old woman developed a severe cough, burning of her eyes and throat, shortness of breath, weakness, wheezing, myalgia, headache, and slurred speech approximately 45 minutes after spraying an aerosolized leather-shoe conditioner on a pair of boots. In the emergency room, she had a temperature of 101.1°F, pulse of 100, and a respiratory rate of 28. She had bilateral rales and an arterial oxygen partial pressure (PO_2) of 60 mm Hg on oxygen at 3 L per minute via nasal cannula. A chest x-ray revealed bilateral midzone interstitial infiltrates. Her white blood count was 21,300 cells per mm^3, with 90% segmented forms. Liver function tests, electrolytes, urea, and creatinine were normal. Treatment was initiated with antivirals, antibiotics, and a bronchodilator. By the next day, the patient's dyspnea had resolved, she was afebrile, and her pulse and respiratory rate were normal. A repeat chest x-ray showed almost complete clearing of the pulmonary infiltrates.

An 11-year-old boy, who was in an adjacent room when the patient used the leather conditioner, developed a burning throat, shortness of breath, cough, and abdominal pain approximately 45 minutes after exposure. He did not seek medical attention (29).

These cases represent just two of an estimated 500 cases of adverse responses to leather sprays that were reported in 1992 and 1993. Two different leather sprays were implicated; both had been reformulated to comply with the 1990 amendments to the Clean Air Act. Chemical analyses suggested major alterations in the fluorohydrocarbon constituents of the sprays, and laboratory studies also revealed the toxicity of the new products in animals (30).

This case illustrates toxicity associated with an agent in the home environment rather than the workplace. It also demonstrates how changing a product to reduce adverse environmental impact, in this case to comply with the Clean Air Act in an effort to protect the ozone layer, can have unexpected adverse health consequences.

SUMMARY

The symptoms and physical findings associated with exposure to occupational and environmental hazards are often nonspecific; a suitably high index of suspicion is needed for physicians to detect disease-toxin connections in the workplace. Attention to the occupational history and physical examination, the use of appropriate diagnostic modalities, work-site evaluations, and interactions with other health and safety professionals will enable the clinician to contribute both to the health of the individual patient and to that of the work force as a whole.

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REFERENCES

1. Brancati FL, Hodgson MJ, Korpf M. Occupational exposures and diseases among medical inpatients. *J Occup Med* 1993;35(2):161–165.
2. Department of Health and Human Services. *Healthy People 2000.* DHHS Publication No. 91-50213 (1991). Washington, DC: DHHS.
3. Fleming LE, Ducatman AM, Shalat SL. Disease clusters: a central and ongoing role in occupational health. *J Occup Med* 1989;33(7): 818–825.
4. Chan-Yeung M. Occupational asthma. *Chest* 1990;98(5):148s–161s.
5. Rutstein D, Mullan J, Frazier TM, Halperin WE, Melius JM, Sestito JP. Sentinel health events (occupational): a basis for physician recognition and public health surveillance. *Am J Public Health* 1983;73: 1054–1062.
6. Rosenberg J, Rempel D. Biological monitoring. In: Rempel D, ed. *Occupational medicine:* state of the art reviews, vol. 5, no. 3, *Medical surveillance in the workplace.* Philadelphia: Hanley & Belfus, 1990; 491–498.
7. Conway H, Simmons J, Talbert T. The Occupational Safety and Health Administration's 1990–1991 Survey of Occupational Medical Surveillance Prevalence and Type of Current Practice. *J Occup Med* 1993; 35(7):659–669.
8. Murthy LI, Halperin WE. Medical screening and biological monitoring. A guide to the literature for physicians. *J Occup Environ Med* 1995;37(2):170–184.
9. ILO. *Guidelines for the use of ILO international classification of radiographs of pneumoconioses.* Occupational Safety and Health Series, No. 22 (rev.). Geneva: International Labor Office, 1980.
10. Balmes JR. Medical surveillance for pulmonary endpoints. In: Rempel D, ed. *Occupational medicine:* state of the art reviews, vol. 5, no. 3, *Medical surveillance in the workplace.* Philadelphia: Hanley & Belfus, 1990;499–514.
11. Harrison R. Medical surveillance for workplace hepatotoxins. In: Rempel D, ed. *Occupational medicine:* state of the art reviews, vol. 5, no. 3, *Medical surveillance in the workplace.* Philadelphia: Hanley & Belfus, 1990;515–530.
12. Kosnett MJ. Medical surveillance for renal endpoints. In: Rempel D, ed. *Occupational medicine:* state of the art reviews, vol. 5, no. 3, *Medical surveillance in the workplace.* Philadelphia: Hanley & Belfus, 1990;531–546.
13. Cone JE, Bowler R, So Y. Medical surveillance for neurologic endpoints. In: Rempel D, ed. *Occupational medicine:* state of the art reviews, vol. 5, no. 3, *Medical surveillance in the workplace.* Philadelphia: Hanley & Belfus, 1990;547–562.
14. Cone JE, Rosenberg J. Medical surveillance and biomonitoring for occupational cancer endpoints. In: Rempel D, ed. *Occupational medicine:* state of the art reviews, vol. 5, no. 3, *Medical surveillance in the workplace.* Philadelphia: Hanley & Belfus, 1990;563–582.
15. Rosenberg J, Clever LH. Medical surveillance of infectious disease endpoints. In: Rempel D, ed. *Occupational medicine:* state of the art reviews, vol. 5, no. 3, *Medical surveillance in the workplace.* Philadelphia: Hanley & Belfus, 1990;583–606.
16. Office of the Federal Register. *CFR:* Code of Federal Regulations. Washington, DC: U.S. Government Printing Office, 1910.1200, hazard communication.
17. NIOSH. *Guide to industrial respiratory protection.* Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health, Division of Safety Research, 1987.

18. Snyder TB, Himmelstein J, Pransky G, Beavers JD. Business analysis in occupational health and safety consultations. *J Occup Med* 1991; 33(10):1040–1045.
19. ACGIH. *Air sampling instruments for evaluation of atmospheric contaminants*, 7th ed. Cincinnati, OH: American Conference of Governmental Industrial Hygienists, 1989.
20. ACGIH. *Industrial ventilation*, 20th ed. Cincinnati, OH: American Conference of Governmental Industrial Hygienists, 1988.
21. Matte TD, Fine L, Meinhardt TJ, Baker EL. Guidelines for medical screening in the workplace. In: Rempel D, ed. *Occupational medicine:* state of the art reviews, vol. 5, no. 3, *Medical surveillance in the workplace*. Philadelphia: Hanley & Belfus, 1990:439–456.
22. Checkoway H, Pearce N, Crawford-Brown DJ. *Research methods in occupational epidemiology*. New York: Oxford University Press, 1989.
23. NIOSH. *Hazard evaluation and technical assistance report:* Asbury Graphite Mills, *Inc., Asbury, NJ.* NIOSH Report No. 93-494. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, 1994.
24. NIOSH. *Hazard evaluation and technical assistance report:* Distinctive Designs International, *Inc., Russellville, Alabama*. NIOSH Report No. 91-386-2427. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, 1994.
25. CDC/NIOSH. *Preventing asthma, other respiratory disease, and death due to diisocyanate exposure*. NIOSH Alert, Publication No. 96-111. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, and National Institute for Occupational Safety and Health, March 1996.
26. CDC/NIOSH. *Preventing silicosis and deaths from sandblasting*. NIOSH Alert, Publication No. 92-102. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, and National Institute for Occupational Safety and Health, August 1992.
27. Weber S, Kullman G, Petsonk E, et al. Organic dust exposures from compost handling: case presentation and respiratory exposure assessment. *Am J Ind Med* 1993;24:365–374.
28. CDC/NIOSH. *Preventing organic dust toxic syndrome*. NIOSH Alert, Publication No. 94-102. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, and National Institute for Occupational Safety and Health, April 1994.
29. CDC (Centers for Disease Control and Prevention). Severe acute respiratory illness linked to use of shoe sprays—Colorado, November 1993. *MMWR* 1993;42(46):885–887.
30. Hubbs AF, Castranova V, Ma JYC, et al. Acute lung injury induced by a commercial leather conditioner. *Toxicol Appl Pharmacol* 1997:143; 37–46.