A Practical Approach to Occupational and Environmental Medicine

Third Edition

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Suspecting Occupational Disease: The Clinician's Role

Rose H. Goldman

persons suffering from work-related illness enter clinicians' offices every day. Yet consideration of work-related etiologies rarely enters the practitioner's differential diagnosis. As a result, clinicians may miss the chance to make diagnoses that might influence the course of a disease in some and might prevent disease in others (by stopping exposure). The following two cases illustrate the consequences of attention to (or lack of attention to) environmental exposures:

The first case is a man who experienced retrosternal chest pain after applying a paint remover in his basement workshop (1). On admission to the hospital, he showed the paint-remover container to his attending physician. The label cautioned that the product contained 80% methylene chloride and was to be used only with adequate ventilation. The physician made the diagnosis of anterior wall myocardial infarction but apparently did not look further into the health effects of methylene chloride. After discharge, the patient reused the solvent in a similar manner and suffered a fatal myocardial infarction. This tragic ending might have been averted if the history of solvent exposure had stimulated inquiry into the toxic properties of methylene chloride. If the practitioner had known that this substance is rapidly metabolized to carbon monoxide, which can stress the cardiovascular system (2,3), then he could have advised the patient not to use the solvent, particularly in an unventilated area.

In the second case, in contrast, a young man reported fatigue, headache, and skin rash to his physician. He inquired if his problems could be related to his job, in which he machined metal parts and cleaned them with methylene chloride. The physician knew little about this solvent but was suspicious that it might be a contributing factor. He consulted with an occupational physician and learned that overexposure could cause dizziness, headache, excessive fatigue, and skin irritation. The physician then learned that the patient worked in a small, unventilated basement workshop over an open container of solvent. The patient's job was to dip metal parts into the container of solvent, wetting his arms to the elbow, and then hold the dripping parts up to his eye for close inspection. The occupational physician discussed the dangers of these conditions with the patient and recommended methods for decreasing exposure. The employee persuaded the company to install a safer degreasing operation and also changed his own work practices. When those changes were made, his symptoms resolved.

These two cases demonstrate how a physician's level of attention to potential environmental and occupational hazards can lead to strikingly different outcomes.

It is difficult to estimate the full extent of occupational illness in the United States because of the lack of accurate information. The Bureau of Labor Statistics (BLS) in the U.S. Department of Labor reports statistics based on surveys of private companies with greater than 11 employees, excluding the self-employed, farmers, and government employees. BLS reported 5.7 million nonfatal injuries and illnesses, or 6.1 per 100 full-time workers in 2000 (4). Of the 362,500 new illness cases reported, 67% were disorders related to repeated trauma, such as carpal tunnel syndrome and noise-induced hearing loss. Yet even these Department of Labor statistics are underestimates because of underreporting, lack of identification of cases, the tendency to report predominately acute rather than chronic cases, and failure to include all types of employers. Another study used several collected data sets (including the BLS) to produce the following estimates of annual total occupational injury and illness in the U.S.: 6,500 job-related deaths from

injury; 13.2 million nonfatal injuries; 60,300 deaths from job-related disease; and 862,200 work-related illnesses (5). Total costs were estimated to be $171 billion. In a study of health maintenance organization (HMO) members with adult-onset asthma, 21% were found to meet criteria for asthma attributable to occupational exposures (6). The general environment also contributes to illness. Air pollution, for example, has been linked to increased rates of mortality, in particular from cardiovascular and respiratory illnesses (7–9). Home exposures to dust mites and cockroaches (10) as well as work exposures (6,11) are thought to have contributed to the increased incidence and mortality of asthma in both adults and children (12).

Clinicians have an important role to play in identifying potential workplace risks and possible work-related health problems in their patients. One obstacle to physicians' recognition of job-related health problems is insufficient education. A survey in 1983 showed that 50% of medical schools taught courses in occupational health, but the average curriculum time was only 4 hours (13). The Institute of Medicine has recommended how to foster the role and education of the primary care physician in environmental and occupational medicine (14). Now practitioners have many resources available to help them learn more about recognizing and preventing occupational diseases and illnesses, including useful review articles on occupational medicine topics (15–19), paperback textbooks (20,21), comprehensive reference textbooks (22), and Web sites that provide educational materials *(www.aoec.org)* and/or lists of other informative Web sites and resources *(www.acoem.org; http://occ-env-med.mc.duke.eduoemindex2.htrm)*.

Another impediment to the recognition of work-related illness is a lack of uniqueness in the clinical manifestations of many occupational illnesses. Wheezing caused by platinum salts, for example, is similar to wheezing due to animal dander or pollen. Oat-cell carcinoma caused by exposure to bis-

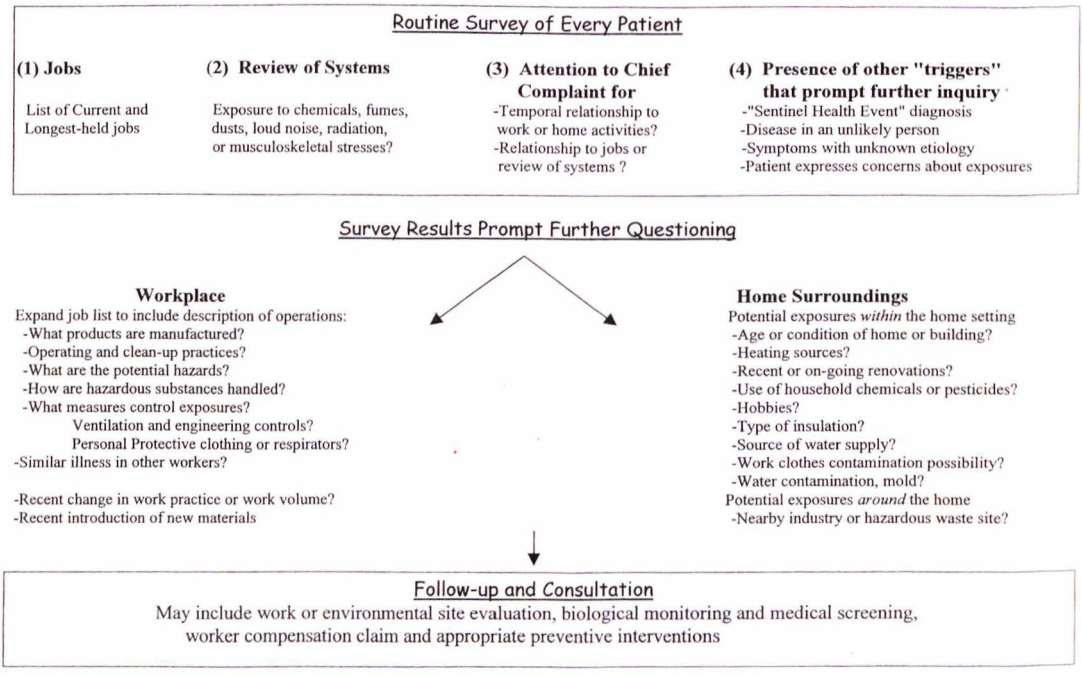

FIG. 20.1. Systematic approach to history taking and diagnosis of occupational or environmental illness. (From Goldman RH, Peters JM. The occupational and environmental health history. *JAMA* 1981;246:2831, © 1981, American Medical Association.)

chloromethyl ether behaves similarly to that due to cigarette smoking. Hepatitis secondary to hepatitis B virus contracted from contact with blood at work presents in the same way as community-acquired hepatitis; median nerve entrapment related to repetitive motions has the same constellation of symptoms and signs as carpal tunnel syndrome due to pregnancy.

Some exposures cause immediate or subacute symptoms (such as allergic reactions and asthma), while others lead to more delayed effects (such as cancer or pneumoconiosis). A long latency, or the period from initial exposure to presentation of disease, is another factor that leads to underrecognition of some occupational diseases. Asbestosis, for example, can appear 15 to 20 years after first working with the material. Occupational cancer such as mesothelioma can occur 40 years after exposure.

Despite these obstacles, physicians can enhance their recognition of occupational disease by taking a good occupational and environmental (OE) history using an organized approach (Fig. 20.1) (23,24).

OCCUPATIONAL AND ENVIRONMENTAL HEALTH SURVEY OF ALL PATIENTS

Patients with symptoms related to hazardous exposures can present with complaints involving any body system and mimicking ordinary medical diseases (Table 20.1) (23,24). To detect cases of occupational disease, an OE history, even if brief, should be taken on every patient. With this in mind, the first step in the OE history is a brief survey of all patients that could include the following:

1. A list of current and longest held jobs, and a current job description.
2. Attention to the chief complaint (or diagnosis) for clues suggesting a relationship to activities at work or at home.
3. A review-of-systems question about exposures to fumes, dusts, chemicals, loud noise, radiation, or musculoskeletal stresses.
4. Observance of the presence of other triggers that prompt further inquiry, such as a sentinel health event diagnosis, disease in an unlikely person, symptoms with unknown etiology, and/or patient with concerns about exposures.

The importance of a screening survey on all patients is illustrated by a case report of a young man who presented to an emergency room with abdominal pain and vomiting (25). He underwent an appendectomy before it was learned that his job entailed removing lead paint from houses and that the actual cause of his symptoms was lead poisoning. Even a brief occupational history at the time of his presentation could have provided clues to the correct diagnosis and might have avoided an unnecessary operation. His diagnosis of lead poisoning led to the screening of other workers, and to modifications that would prevent lead exposure in other employees.

In looking for a temporal relationship to work, it is preferable to start with nonsuggestive questions, such as "Are your symptoms better or worse at home or at work? Weekends or workdays?" rather than using more leading questions such as "Does work make you sick?" In some cases the screening OE survey suggests a temporal relationship that points to the role of work or environmental factors: the painter who has been scraping old paint and has abdominal pain (lead poisoning); a car painter with a dry, hacking cough that occurs at work or late in the day or evening [delayed bronchospasm due to exposure to toluene diisocyante (TDI), a component in the car paint lacquer]; the mother and other family members who develop headaches in the fall that are worse in the morning and when at home (carbon monoxide poisoning possibly due to a faulty furnace). Finding a temporal relationship between symptoms and exposure is useful, but it is also important to realize that in some cases current exposures do not always lead to immediate symptoms. For example, a lab technician may have been at work for several months before developing itching, hand rash, and wheezing when putting on latex gloves. He might have developed an allergy to latex. In the case of allergic reactions, it may take months of exposure before sensitization and clinical allergy develops. Once the allergic reaction (skin rash and/or asthma) occurs, symptoms can sometimes extend beyond the work period, and then be triggered by exposure to irritants as well.

Symptoms related to current exposures may initially improve on nonworkdays or vacations, but prolonged exposure can lead to the persistence of symptoms beyond the workday. As an example, aching in the wrist and hand of a computer programmer using a mouse might initially resolve with rest in the evenings, on weekends, or vacations. Once chronic tendonitis or nerve entrapment (carpal tunnel or cubital tunnel syndromes) develops, the symptoms can persist into nonwork time and be aggravated by other activities such as biking or gardening.

TABLE 20.1. *Examples of environmental causes of medical problems*

Problem	Agent	Potential exposures
Immediate or short-term effects		
Dermatoses (allergic or irritant)	Metals (chromium, nickel), fibrous glass, epoxy resins, cutting oils, solvents, caustic alkali, soaps	Electroplating, metal cleaning, plastics, machining, leather tanning, housekeeping
Headache	Carbon monoxide, solvents	Firefighting, automobile exhaust, foundry, wood finishing, dry cleaning
Acute psychoses	Lead (especially organic) mercury, carbon disulfide	Handling gasoline, seed handling, fungicide, wood preserving, viscose rayon industry
Asthma or dry cough	Formaldehyde, toluene diisocyanate, animal dander	Textiles, plastics, polyurethane kits, lacquer use, animal handling, latex glove use
Pulmonary edema, pneumonitis	Nitrogen oxides, phosgene, halogen gases, cadmium	Welding, farming ("silo-filler's disease") chemical operations, smelting
Cardiac arrhythmias	Solvents, fluorocarbons	Metal cleaning, solvents use, refrigerator maintenance, auto exhaust
Angina	Carbon monoxide	Car repair, traffic exhaust, foundry, wood finishing
Abdominal pain	Lead	Battery making, enameling, smelting, painting, welding, ceramics, plumbing, radiator repair
Hepatitis (may become a long-term effect)	Halogentated hydrocarbons, e.g., carbon tetrachloride,viral infection	Solvent use, lacquer use, hospital work
Tendinitis, Carpal Tunnel Syndrome, "repetitive strain disorder" (may become a long-term effect)	Repetitive motions, awkward postures, pinching motions, wrist flexion	Assembly work, keyboarding, data entry
Latent or long-term effects		
Chronic dyspnea		
Pulmonary fibrosis	Asbestos, silica, beryllium, coal, aluminum	Mining insulation, pipefitting, sandblasting, quarrying, metal alloy work, aircraft or electrical parts, nylon flocking
Chronic bronchitis emphysema	Cotton dust, cadmium coal dust, organic solvents, cigarettes	Textile industry, battery production, soldering, mining, solvent use
Lung cancer	Asbestos, arsenic, uranium, coke oven emissions	Insulation, pipefitting, smelting, coke ovens, shipyard workers, nickel refining, uranium mining
Bladder cancer	β-Naphthylamine, benzidine dyes	Dye industry, leather, rubber-working chemists
Peripheral neuropathy	Lead, arsenic *n*-hexane, methyl butylketone, acrylamide	Battery production, plumbing, smelting, painting, shoemaking, solvent use, insecticides
Behavioral changes	Lead, carbon disulfide, solvents, mercury, manganese	Battery makers, smelting, viscose rayon industry, degreasing, mfg/repair of scientific instruments, dental amalgam workers
Extrapyramidal syndrome	Carbon disulfide, manganese	Viscose rayon industry, steel production, battery production, foundry, mining
Aplastic anemia, leukemia	Benzene, ionizing radiation	Chemists, furniture refinishing, cleaning, degreasing, radiation workers

From Goldman RH, Peters JM. The occupational and environmental health history. *JAMA* 1981;246:2831. © 1981, American Medical Association.

Exposure to occupational or environmental substances can also aggravate underlying medical conditions. For example, carbon monoxide inhalation, even at the relatively modest levels of exposure encountered during commuter driving in heavy traffic, may precipitate anginal symptoms or decreased exercise tolerance in patients with coronary artery disease (2,3,26). The expression of toxic symptoms is also influenced by the presence of other diseases, genetic traits, medications, and exposure to other hazardous substances. For example, the metabolism of certain poisons may be affected by liver disease, certain medications, concurrent alcohol use, chemicals (such as DDT), and/or any condition that affects liver function.

Other triggers may prompt the need for further inquiry: The presence of a "sentinel health event (occupational)" diagnosis is a disease, disability, or untimely death that is occupationally related and whose occurrence may provide the impetus for evaluations (such as epidemiologic studies or industrial hygiene evaluations) and interventions to prevent future cases (27,28). Table 20.2 is an abbreviated list of these characteristic diagnoses (16).

TABLE 20.2. *Occupationally related unnecessary disease, disability, and untimely death*[a]

ICD-9	Condition	A	B	C	Industry/process/occupation	Agent
011	Pulmonary tuberculosis (O)	P	P,T	P,T	Physicians, medical personnel, medical lab workers	*Mycobacterium tuberculosis*
011, 502	Silicotuberculosis	P	P,T	P,T	Quarrymen, sandblasters, silica processors, mining, metal foundries, ceramic industry	Silica + *Mycobacterium tuberculosis*
020	Plague (O)	P	—	—	Shepherds, farmers, ranchers, hunters, field geologists	*Yersinia pestis*
021	Tularemia (O)	P	—	P,T	Hunters, fur handlers, sheep industry workers, cooks, vets, ranchers, vet pathologists, lab workers, soldiers	*Francisella tularensis, Pasteurella tularensis*
022	Anthrax (O)	P	—	P,T	Shepherds, farmers, butchers, handlers of imported hides or fibers, vets, vet pathologists, weavers, farmers	*Bacillus anthracis*
023	Brucellosis (O)	P	P	P	Farmers, shepherds, veterinarians, lab workers, slaughterhouse workers, field officers	*Brucella abortus, suis*
031.1[b]	Fish-fancier's finger (O)	P	P	P	Aquarium workers/cleaners, breeders/owners Longshoremen	*Mycobacterium marinum* *Mycobacterium marinum*
054.6	Herpetic whitlow (O)	P	P	P	Surgical residents, student nurses, nurses, dental assistants, physicians, orthopedic scrub nurses, psychiatric nurses	Herpes simplex virus
037	Tetanus(O)	P	P	P	Farmers, ranchers	*Clostridium tetani*
042[c]	Human immunodeficiency virus (O)	P	P	P	Health care workers	Human immunodeficiency virus
056	Rubella (O)	P	P	P	Medical personnel, intensive care personnel	Rubella virus
070.0.1	Hepatitis A (O)	P	P	P	Day-care center staff, orphanage staff, mental retardation institution staff, medical personnel	Hepatitis A virus
070.2.3	Hepatitis B (O)	P	P	P	Nurses and aides, anesthesiologists, orphanage and mental institution staff, medical lab personnel, general dentists, oral surgeons, physicians	Hepatitis B virus
070.4	Non-A, non-B hepatitis (O)	P	P	P	As above for hepatitis A and B	Unknown
071	Rabies (O)	P	—	P	Veterinarians, animal and game wardens, lab researchers, farmers, ranchers, trappers	Rabies virus
073	Ornithosis (O)	P	—	P,T	Psittacine bird breeders, pet shop staff, poultry producers, vets, zoo employees, duck processing and rearing	*Chlamydia psittaci*
082.0	Rocky Mountain spotted fever (O)	P	P	P,T	Laboratory technicians, tick breeders, virologists, microbiologists, physicians	*Rickettsia rickettsii*
100.8	Leptospirosis (O)	P	P	P,T	Farmers/laborers	*Leptospira*
115	Histoplasmosis (O)	P	P	P,T	Bridge maintenance workers	*Histoplasma capsulatum*
117.1	Sporotrichosis (O)	P	P	P	Nurserymen, foresters, florists, equipment operators	*Sporothrix schenckii*
147	Malignant neoplasm of nasopharynx (O)	P	P	P	Carpenters, cabinet makers, sawmill workers, lumberjacks, electricians, fitters	Chlorophenols
155M[d,e]	Hemangiosarcoma of the liver	P	P	P	Vinyl chloride polymerization industry Vintners	Vinyl chloride monomer Arsenical pesticides
158, 163	Mesothelioma (MN of peritoneum and pleura)	P	—	P	Asbestos industries and utilizers	Asbestos

continued on next page

TABLE 20.2. *Continued*

ICD-9	Condition	A	B	C	Industry/process/occupation	Agent
160.0	Malignant neoplasm of nasal cavities (O)	P	P,T	P,T	Woodworkers, cabinet and furniture makers	Hardwood dusts
					Boot and shoe industry	Unknown
					Radium chemists and processors, dial painters	Radium
					Chromium producers, processors, users	Chromates
					Nickel smelting and refining	Nickel
					Sawmill workers, carpenters	Chlorophenols
161	Malignant neoplasm of larynx (O)	P	P,T	P,T	Asbestos industry and utilizers	Asbestos
162	Malignant neoplasm of trachea, bronchus, and lung (O)	P	P	P	Asbestos industry and utilizers	Asbestos
					Topside coke oven workers	Coke oven emissions
					Uranium and fluorspar miners	Radon daughters
					Chromium producers, processors, users	Chromates
					Nickel smelters, processors, users	Nickel
					Smelters	Arsenic, arsenic trioxide
					Mustard gas formulators	Mustard gas
					Ion exchange resin makers, chemists	Bis(chloromethyl) ether, chloromethyl methyl ether
					Iron ore (underground) miners	Radon daughters
					Plant protection workers/agronomists	Pesticides, herbicides, fungicides, insecticides
					Welders	Unknown
					Copper smelter and roaster workers	Inorganic arsenic sulfur dioxide, copper, lead, sulfuric acid, arsenic trioxide
					Welders, gas cutters	Asbestos, hexavalent chromium
					Foundry-floor molders and casters	Polyaromatic hydrocarbons
					Dichromate production-floor molders/casters	Unknown
					Chromate production	Chromium dust
					Chromate pigment production workers	Lead chromate, zinc chromate
					Pigment production	Zinc chromate dust
					Steel industry-furnace/foundry workers	Unknown
					Rubber reclaim operations	Unknown
170	Malignant neoplasm of bone (O)	P	—	P	Radium chemists and processors, dial painters	Radium
187.7	Malignant neoplasm of scrotum	P	—	P,T	Automatic lathe operators, metal workers	Mineral/cutting oils
					Coke oven workers, petroleum refiners, tar distillers	Soots/tars/tar distillates
					Tool setters, fitters, cotton spinners, chimney sweeps, machine operators	Mineral oil, pitch, tar
188	Malignant neoplasm of bladder (O)	P	—	P	Rubber and dye workers	Benzidine, α- and β-naphthylamine, magenta, auramine, 4-aminobiphenyl, 4-nitrophenyl

189	Malignant neoplasm of kidney, other, and unspecified urinary organs (O)	P	P	P	Coke oven workers	Coke oven emissions
204.0	Lymphoid leukemia, acute (O)	P	—	P	Rubber industry	Unknown
					Radiologists	Ionizing radiation
205.0	Myeloid leukemia, acute (O)	P	—	P	Occupations with exposure to benzene	Benzene
					Radiologists	Ionizing radiation
207.0	Erythroleukemia (O)	P	—	P	Occupations with exposure to benzene	Benzene
283.1	Hemolytic anemia, nonautoimmune (O)	P	—	P	Whitewashing and leather industry	Copper sulfate
					Electrolytic processes, arsenical ore smelting	Arsine
					Plastics industry	Trimellitic anhydride
					Dye, celluloid, resin industry	Naphthalene
284.8	Aplastic anemia (O)	P	—	P	Explosives manufacture	Trinitrotoluene
					Occupations with exposure to benzene	Benzene
					Radiologists, radium chemists, and dial painters	Ionizing radiation
288.0	Agranulocytosis or neutropenia (O)	P	—	P	Occupations with exposure to benzene	Benzene
					Explosives and pesticide industries	Phosphorus
					Pesticides, pigments, pharmaceuticals	Inorganic arsenic
289.7	Methemoglobinemia (O)	P	—	P,T	Explosives and dye industries	Aromatic amino and nitro compounds (e.g., aniline, trinitrotoluene, nitroglycerin)
					Rubber workers	Aniline, o-toluidine, nitrobenzene
323.7	Toxic encephalitis (O)	P	P	P	Battery, smelter, and foundry workers	Lead
					Electrolytic chlorine production, battery makers, fungicide formulators	Inorganic and organic mercury
332.1	Parkinson's disease (secondary) (O)	P	P	—	Manganese processing, battery makers, welders	Manganese
					Internal combustion engine industries	Carbon monoxide
334.3	Cerebellar ataxia (O)	P	P	—	Chemical industry using toluene	Toluene
					Electrolytic chlorine production, battery makers, fungicide formulators	Organic mercury
354M[f]	Carpal tunnel syndrome (O)	P	P	—	Meat packers deboners	Cumulative trauma
354.0.2.3	Mononeuritis of upper limb and mononeuritis multiplex (O)	P	P	—	Dental technicians	Methyl methacrylate monomer
					Poultry processing—turkey	Cumulative trauma
					Meatpackers, deboners	Cumulative trauma
357.7	Inflammatory and toxic neuropathy (O)	P	P,T	P,T	Pesticide industry, pigments, pharmaceuticals formulators	Arsenic/arsenic compounds
					Furniture refinishers, degreasing operations	Hexane
					Plastic-coated fabric workers	Methyl *n*-butyl ketone
					Explosives industry	Trinitrotoluene
					Rayon manufacturing	Carbon disulfide
					Plastics, hydraulics, coke industries	Tri-o-cresyl phosphate
					Battery, smelter, and foundry workers	Inorganic lead
					Dentists, chloralkali workers	Inorganic mercury
					Chloralkali plants, fungicide makers, battery makers	Organic mercury

continued on next page

TABLE 20.2. *Continued*

ICD-9	Condition	A	B	C	Industry/process/occupation	Agent
					Plastics industry, paper manufacturing	Acrylamide
					Ethylene oxide sterilizer operator	Ethylene oxide
366.4	Cataract (O)	P	P,T	—	Microwave and radar technicians	Microwaves
					Explosives industries, trinitrotoluene workers	Trinitrotoluene
					Radiologists	Ionizing radiation
					Blacksmiths, glass blowers, bakers	Infrared radiation
					Moth repellant formulators, fumigators	Naphthalene
					Explosives, dye, herbicide and pesticide industries	Dinitrophenol, dinitro-o-cresol
					Ethylene oxide sterilizer operator, microbiology supervisors, inspectors	Ethylene oxide
388.1	Noise effects on inner ear (O)	P	P	—	Occupations with exposure to excessive noise	Excessive noise
443.0	Raynaud's phenomenon (secondary) (O)	P	—	—	Lumberjacks, chain sawyers, grinders, chippers, rock drillers, stone cutters, jackhammer operators, riveters	Whole body or segmental vibration
					Vinyl chloride polymerization industry	Vinyl chloride
493.0	Extrinsic as-	P	P,T	P,T	Jewelry, alloy, and catalyst makers	Platinum
507.8	T ham (O)				Polyurethane, adhesive, paint workers	Isocyanates
					Alloy, catalyst, refinery workers	Chromium, cobalt
					Solderers	Aluminum soldering flux
					Plastic, dye, insecticide makers	Phthalic anhydride
					Foam workers, latex makers, biologists	Formaldehyde
					Printing industry	Gum arabic
					Nickel platers	Nickel sulfate
					Bakers	Flour
					Plastics industry, organic chemicals manufacture	Trimellitic anhydride
					Woodworkers, furniture makers	Red cedar (plicatic acid) and other wood dusts
					Detergent formulators	Bacillus-derived exoenzymes
					Crab processing workers	Unknown
					Hospital and geriatric department nurses	Psyllium dust
					Laxative manufacture and packing	Psyllium dust
					Prawn processing workers	Unknown
					Snow crab processing workers	Unknown
495.4	Maltworker's lung	P	P	—	Maltworkers	*Aspergillus clavatus*
495.5	Mushroom worker's lung	P	P	—	Mushroom farm/spawning shed, farmers	Pasteurized compost
495.8	Grain handler's lung	P	P	—	Grain handlers	Erwinia herbicola *(Enterobacter agglomerans)*
	Sequoiosis	P	P	—	Red cedar mill workers, woodworkers, sawmill, joinery	Redwood sawdust, *Thuja plicata*
495.9	Unspecified allergic alveolitis	P	P	—	Cinnamon processing workers	Cinnamon dust, cinnamaldehyde
					Distillery, vegetable compost plant workers	*Aspergillus fumigatus*
					Sawmill workers	Unknown

					Paper manufacture/wood room	*Alternaria*, wood dust
					Snow crab processing workers	Unknown
500	Coalworker's pneumoconiosis	P	P	P	Coal miners	Coal dust
501	Asbestosis	P	P	P	Asbestos industries and utilizers	Asbestos
502M[g]	Silicosis	P	P	P	Quarrymen, sandblasters, silica processors, mining, metal, and ceramic industries	Silica
					Cryolite refining	Cryolite (Na_3AlF_6), quartz dust
	Talcosis	P	P	P	Talc processors, soap stone mining/milling, polishing, cosmetics industry	Talc
503M[h]	Chronic beryllium disease of the lung	P	P	P	Beryllium alloy workers, ceramic and cathode ray tube makers, nuclear reactor workers	Beryllium
504	Byssinosis	P	P	P	Cotton industry workers	Cotton, flax, hemp, and cotton-synthetic dusts
506.0.1	Acute bronchitis, pneumonitis, and pulmonary edema due to fumes and vapors (O)	P,T	P,T	P,T	Refrigeration, fertilizer, oil refining industries	Ammonia
					Alkali and bleach industries	Chlorine
					Silo fillers, arc welders, nitric acid industry	Nitrogen oxides
					Paper and refrigeration industries, oil refining	Sulfur dioxide
					Cadmium smelters, processors	Cadmium
					Plastics industry	Trimellitic anhydride
					Boilermakers	Vanadium pentoxide
					Organic chemicals manufacture	Trimellitic anhydride
570, 573.3	Toxic hepatitis (O)	P	P	P	Solvent utilizers, dry cleaners, plastics industry	Carbon tetrachloride, chloroform, tetrachloroethane, trichloroethylene, tetrachloroethylene
					Explosives and dye industries	Phosphorus, trinitrotoluene
					Fire and waterproofing additive formulators	Chloronaphthalenes
					Plastics formulators	Methylenedianiline
					Fumigators, gasoline and fire extinguisher formulators	Methyl bromide, ethylene dibromide
					Disinfectant, fumigant, synthetic resin formulators	Cresol
584, 585	Acute or chronic renal failure (O)	P	P,T	P,T	Battery makers, plumbers, solderers	Inorganic lead
					Electrolytic processes, arsenical ore smelting	Arsine
					Battery makers, jewelers, dentists	Inorganic mercury
					Fluorocarbon formulators, fire extinguisher makers	Carbon tetrachloride
					Antifreeze manufacture	Ethylene glycol
					Chromate pigment production workers	Inorganic lead
606	Infertility, male (O)	P	P	—	Kepone formulators	Kepone
					Dibromochloropropane (DBCP) producers, formulators, and applicators	DBCP
692	Contact and allergic dermatitis (O)	P,T	P,T	—	Leather tanning, poultry dressing plants, fish packing, adhesives and sealants industry, boat building and repair	Irritants (e.g., cutting oils, phenol, solvents, acids, alkalis, detergents); allergens (e.g., nickel, chromates, formaldehyde, dyes, rubber products)

continued on next page

TABLE 20.2. *Continued*

ICD-9	Condition	A	B	C	Industry/process/occupation	Agent
733.9M[i]	Skeletal fluorosis (O)	P	P	—	Cryolite workers (grinding room) Cryolite refining workers	Cryolite (Na_3AlF_6) Cryolite (Na_3AlF_6)

Key: A = unnecessary disease; B = unnecessary disability; C = unnecessary untimely death; P = prevention; T = treatment.

[a]External causes of injury and poisoning (occupational), including accidents, are classified in the *International Classification of Diseases,* 9th revision, under the E codes.

[b]Original ICD rubric = cutaneous diseases due to other mycobacteria.

[c]From the *International Classification Diseases,* 9th revision, clinical modification (ICD-9-CM).

[d]M, modified ICD rubric.

[e]Original ICD rubric = malignant neoplasm of liver and intrahepatic bile ducts.

[f]Original ICD rubric = mononeuritis of upper limb and mononeuritis multiplex.

[g]Original ICD rubric = pneumoconiosis due to other silica or silicates.

[h]Original ICD rubric = pneumoconiosis due to other inorganic dust.

[i]Original ICD rubric = other disorders of bone and cartilage.

From Mullan RJ, Murthy LI. Occupational sentinel health events: an updated list for physician recognition and public health surveillance. *Am J Ind Med* 1991;19:775.

The occurrence of an illness in an unexpected person (e.g., lung cancer in a nonsmoker) may also stimulate the clinician to delve further into potential contributing environmental or occupational exposures. Sometimes the clinician observes an unusual disease in several patients. Searching for a connection among the cases may reveal that a work exposure is the common link. In fact, an occupational disease may be discovered that has not been previously described. Examples include the first description of occupational cancer, credited to Percival Potts, a surgeon who noted an increased frequency of scrotal cancer among chimney sweeps, which he attributed to the soot collected on their clothes and skin (29); the observation of several cases of angiosarcoma of the liver in employees of a rubber company, which led to the discovery of the causative agent vinyl chloride monomer (30); the detection of a bladder neurotoxin when a group of workers presented with urinary problems, which traced to the toxic effects of a newly introduced catalyst (31); and a high prevalence of sarcoidosis in Salem, Massachusetts ("Salem sarcoid"), linked to employees working in companies making light bulbs and eventually attributed to beryllium exposure (32). In these cases, identification of the causative agents led to better control over exposures and reduction in associated diseases.

Something elicited in the occupational/environmental history survey questions may raise the practitioner's suspicions that the patient's condition is related to an environmental or work exposure, thus prompting further questioning and gathering of information about work and home exposures.

DEFINING AND DESCRIBING THE SOURCES OF EXPOSURE

Workplace

1. List *all* significant jobs.
2. Note places of employment and products manufactured.
3. Obtain a thorough description of the operations performed by the worker on the relevant jobs, including hazardous agents, and protective measures.
4. Inquire about illnesses in other workers on the relevant jobs.

Although a brief list of job titles may be adequate as a part of the screening or initial medical examination, the practitioner evaluating potential occupational illness must take a more detailed history. In the case of latent diseases, an exposure occurring many years before the onset of symptoms may be responsible for the disorder. This point is illustrated by a 47-year-old worker with dyspnea whose roentgenogram showed bilateral pleural thickening and linear reticular parenchymal infiltrates consistent with asbestosis (33). Sixteen years earlier he worked for 9 months in a factory making cigarette filters that contained asbestos.

A worker's description of job duties may reveal potential hazards not suggested by the job title. The worker should describe the tasks he/she performs, the agents handled, and the working conditions. The characterization of hazardous exposure(s) includes the following:

1. Determining the generic name, if a chemical; describing the physical form, if a dust; or determining what form, if radiation.
2. Describing how a substance is handled: What are the operating or cleanup practices? What protective measures are used? Is a respirator worn and properly maintained? Is it the proper respirator given the type and quantity of exposure. Is protective clothing used? Is ventilation adequate? Are there engineering controls?
3. Considering the mode of entry: Is it ingested by eating at the workplace? Inhaled through generation of fumes or vapors? Chance of skin contact and skin absorption?

To characterize the health effects of a chemical substance, it is helpful to know its generic ingredients. To obtain this information, the practitioner can ask the worker or manufacturer for the Material Safety Data Sheet (MSDS) that usually lists the product's ingredients, physical properties, and some environmental protection information. The federal Chemical Hazard Communication Standard (29 CFO 1910.1200) and various state "right to know" laws (34) require that the employer provide employees with detailed information about hazardous chemicals used in the workplace. In general, the worker should be taught about the hazards of certain materials and properly trained in safe work practices. The standard stipulates that the employer must respond to an employee's request for an MSDS within 72 hours. Poison control centers are reliable resources for toxicologic information on many toxins and often can identify the generic name of many trade substances. Once the generic name is known, more information can be found from toxin-oriented texts (35), and by searching the Web and performing literature searches.

The clinician can also obtain more information about the type of hazardous exposures associated

with certain jobs or work processes, by consulting references that describe hazards associated with industrial processes (36–39). Sometimes the worker may not have all the specific information concerning the exposures. The practitioner can also ask the patient about contacting the plant physician, manager, or union official to obtain more information, and/or requesting an evaluation by a governmental or private agency. It is frequently very useful to obtain and review any industrial hygiene or air quality evaluations that may have already been performed.

Home Surroundings

The routine survey questions may suggest that the symptoms relate to hazardous materials or conditions in the home. Possible internal sources of hazards in the home environment include household chemicals and pesticides, performance of certain hobbies (40), presence of biologic contamination (41,42), faulty heating system, water and food contamination, and transport of toxic dust or chemicals into the home on work clothes. Due to inadequate labeling, home residents may be inadvertently exposed to hazardous chemicals in aerosol sprays, cleaning fluids, disinfectants, or insecticides (Table 20.3). Methylene chloride, for example, is a frequent component of many household products, such as paint strippers. Rust removers may contain hydrofluoric acid, which can produce deep penetrating burns on skin contact. Without proper handling instructions, people may unsuspectingly develop a variety of symptoms and health problems from the use of these materials. Even mild exposure to certain materials causes allergic reactions in susceptible persons. Dangerous situations may arise when two substances are mixed to produce a more potent cleaning agent. Mixing ammonia and sodium hypochlorite (bleach), for example, can lead to the generation of chloramine gas (43), which in some cases can cause toxic pneumonitis and/or asthma.

The growth and diversification of hobbies may involve the use of various hazardous substances (40), which are then introduced into the household (Table 20.4). If a home studio is poorly ventilated and unkempt, all family members may be exposed to toxic substances.

Concerns over indoor air quality in the home have grown, particularly in reaction to the increasing use of energy-saving insulation, frequently installed without adequate ventilation, and sometimes leading to poor air circulation and the accumulation of potentially toxic agents [e.g., carbon monoxide, volatile organic compounds (VOCs), biologic aerosols] in the air (41,42,44,45).

Dust or chemicals carried into the home on work clothes have led to excessive lead exposure in children (46) and mesothelioma in family members of asbestos workers (47).

External sources of exposures include industrial effluents emitted into the air, water, or grounds of homes. Community contamination from toxic waste sites has been a growing public health concern. Some

TABLE 20.3. *Examples of common dangerous household products*

Product	Potentially hazardous agents
Disinfectants	Cresol; phenol; hexachlorophene
Cleaning agents and solvents	
Bleaches	Sodium hypochlorite (Clorox)
Window cleaner	Ammonia
Carpet cleaner	Ammonia, turpentine, naphthalene: 1.1.1-trichloroethane
Oven and drain cleaners	Potassium hydroxide, sodium hydroxide
Dry cleaning fluids, spot removers	1.1.1-Trichloroethane, perchlorethylene, petroleum distillates
Paint and varnish solvents	Turpentine, xylene, toluene, methanol, methylene, chloride, acetone
Pesticides	Malathion, dichlorvos, carbaryl, methoxychlor
Emissions from heating and cooling devices	
Gas stove pilot light	Nitrogen oxides
Indoor use of charcoal grill	Carbon monoxide
Leaks from refrigerator or air conditioning cooling systems	Freon
Microwave ovens	Microwave radiation
Sun lamps	Ultraviolet radiation

From Goldman RH, Peters JM. The occupational and environmental health history. *JAMA* 1981;246:2831. © 1981, American Medical Association.

TABLE 20.4. *Examples of hazards in hobbies*

Activity	Potential hazard
Painting	Toxic pigments, e.g., arsenic (emerald green), cadmium, chromium, lead, mercury; acrylic emulsions, solvents
Ceramics	
Raw materials	Colors and glazes containing barium carbonate; lead, chromium, uranium, cadmium
Gas-fired kilns	Carbon monoxide
Sculpture and casting	
Grinding silica-containing stone	Silica (silicon dioxide)
Serpentine rock with asbestos	Asbestos
Woodworking	Wood dust
Metal casting	Metal fume, sand (silica) from molding, binders, or phenol formaldehyde or urea formaldehyde
Welding	Metal fume, ultraviolet light exposure, welding fumes, carbon dioxide, carbon monoxide, nitrogen dioxide, ozone, or phosgene (if solvents nearby)
Plastics	Monomers released during heating (polyvinyl chloride), methyl methacrylate, acrylic glues, polyurethane (toluene 2,4-diisocyanate), polystyrene (methyl chloride release), fiber glass, polyester, or epoxy resins
Woodworking	Solvents, especially methylene chloride
Photography	
Developer	Hydroquinone, metal
Stop bath	Weak acetic acid
Stop hardener	Potassium chrome alum (chromium)
Fixer	Sodium sulfite, acetic acid, sulfuric acid
Hardeners and stabilizers	Formaldehyde

From Goldman RH, Peters JM. The occupational and environmental health history. *JAMA* 1981;246:2831. © 1981, American Medical Association.

prominent examples of environmental contamination that have aroused concern include polybrominated biphenyls in Michigan, toxic wastes at Love Canal, and arsenic in Bangladesh. Affected persons usually present to their local physician with their health complaints. When concerned about exposures from external sources, the clinician might inquire whether similar symptoms have occurred in neighbors, the location of the home (near a factory, construction area, or hazardous waste site?), sources of water supply and possibilities for contamination, or any noticeable changes in the neighborhood air or water quality. On rare occasions, sudden environmental disaster occurs, such as railroad or truck collisions, factory fires, or explosions that release toxic materials into the community. Both immediate health problems and delayed effects may develop.

Even when evaluating a presumed occupational health problem, a good history concerning home exposures is essential. For example, in the investigation of elevated blood lead level in a foundry worker, one might learn that a home renovation project involved removal of lead paint, which could be another source of lead exposure.

QUANTIFYING EXPOSURES

Once potential exposures have been identified, the next question is whether or not exposure has actually occurred, and if so to what degree. Documenting and quantifying exposures can involve performing biologic monitoring tests of the affected person as well as evaluating the work or environmental site. Within the office setting the patient can be tested for evidence of exposure in body fluids (biologic monitoring) or of adverse health effects upon target organs. The practitioner must know what agent to look for, the desirable test medium (urine, blood, hair, tissue), appropriate timing, and influences upon test results (48). For example, blood carboxyhemoglobin, a measure of exposure to carbon monoxide, should be performed as soon as possible after exposure since the half-life of carbon monoxide in the body is approximately 4 hours when breathing room air. Urine arsenic is a good marker for recent (but not past) exposure since arsenic is excreted rapidly in the urine within a few days. But recent consumption of seafood can lead to increases in total urine arsenic due to the contribution of nontoxic forms of organified arsenic,

thereby leading to mistaken interpretations of elevated arsenic levels. Some chemicals are detected by measurement of metabolites, as in the case of the solvent toluene, which can be assessed with urine metabolites hippuric acid, benzoic acid, and o-cresol. Hair analysis performed by commercial laboratories for multiple toxins and elements have been found to be of poor reliability and accuracy, and have little applicability in most clinical settings (49,50).

Laboratory tests may be performed to look for toxic effects or end-organ damage. As an example, a blood lead concentration could be ordered to assess exposure, and blood urea nitrogen (BUN) and creatinine to look for effects upon the kidneys. Pulmonary function tests and a chest radiograph could assess the effects of past asbestos exposure on the lungs.

It is also important to consider whether the exposed person is particularly vulnerable to the particular exposure. A person with renal disease, for example, might accumulate higher levels of lead than expected secondary to decreased capacity for renal excretion. Children are generally more vulnerable than adults to the effects of toxicants (51).

It is usually important to get exposure information from the environmental location as well, which may involve air sampling, surface samples, water and soil analyses, etc. Sometimes these evaluations can be done privately by certified industrial hygienists and consultants, and in other circumstances through the relevant governmental agencies. These environmental assessments are not only important for diagnosis, but also for planning interventions and prevention of further problems.

FURTHER FOLLOW-UP AND CONSULTATIONS

With exposure data in hand, the clinician can go on to determine if the symptoms and medical findings in the particular patient are consistent with the health effects and time course of toxicity associated with a particular hazardous exposure. In some cases, the correlation between exposure levels (in the environment or the body) and health effects is good, and in other cases poor. Lead, for example, can be measured in air (micrograms per cubic meter) with a reasonable correlation between air levels and blood leads measured in exposed individuals. Although there is considerable individual variation, there is a general correlation between lead exposure and response: in adults, there are usually little or no clinical effects with blood leads below 40 μ/dL; gastrointestinal and cognitive symptoms can appear with levels of 50 μ/dL and above; and anemia seen with levels above 80 μ/dL. In contrast, manganese [of potential importance since an organic form of manganese, methylcyclopentadienyl manganese tricarbonyl (MMT), has recently been approved as a gasoline additive] levels measured in the air are poorly correlated with measurement in the blood. In addition, blood levels of manganese do not correlate well with the appearance of the adverse side effects of manic-depressive symptoms and parkinsonism.

To whom can the practitioner turn for additional consultation and potential intervention? At the local level, state public health or labor departments often have the ability to evaluate work sites. The Occupational Safety and Health Administration (OSHA) performs work-site inspections routinely on a priority basis or at the request of a current worker or management. In some cases, fines may be levied if OSHA standards are violated. Other consultative sources include academically affiliated occupational health clinics *(www.aoec.org)* and worker education groups such as the Coalition for Occupational Safety and Health (COSH) groups. The National Institute for Occupational Safety and Health (NIOSH) in Cincinnati, Ohio, can perform health hazard evaluations (HHEs) of workers and work sites in order to detect work-related health problems. Various government agencies such as NIOSH, the Agency for Toxic Substance Disease Registry (ATSDR), the Environmental Protection Agency (EPA), and their respective Web sites can also provide the practitioner with toxicologic and therapeutic information, published materials on various hazards, and recommendations for further medical care. Experts from any of these sources can investigate the problem further and suggest measures to prevent further exposure or illness in workers at the job site. Industrial hygienists from private consulting groups or from workers' compensation carriers can conduct work-site air monitoring and provide plans for remediating the problems.

For job-related injuries, the practitioner can also help an affected worker obtain workers' compensation when justified (see Chapter 18). The definition of "job related" may vary by state, but usually implies that work responsibilities precipitated, hastened, aggravated, or contributed to the injury or illness. Workers' compensation provides benefits for work time lost, permanent disability, medical care expenses, and rehabilitation. The practitioner should become familiar with the state regulations related to workers' compensation through the medical society or department of health or labor.

SUMMARY

The identification of work- or environmentally related disease is an important task for all practitioners. Thousands of chemical substances are commonly used in industry, and several hundred new substances are introduced to industrial processes each year. Unpredicted health hazards from new processes continue to emerge, and well-known toxins such as lead and certain solvents still escape surveillance and control. Equipped with an awareness and the approach outlined in this chapter, the practitioner can play an important role in the detection and prevention of occupational and environmental diseases.

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