CHAPTER 32

Addressing Health and Safety Hazards in Specific Industries: Agriculture, Construction, and Health Care

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A 20-year-old immigrant farmworker was asked to place soil around the perimeter of a tarp covering a field that had been fumigated by injecting methyl bromide gas into the soil. The field was to be used to plant strawberries. It was his first day of work, and he was eager to prove that he was a good worker. It was 104°F, and after about 4 hours of this work he began to feel nauseous and dizzy. A co-worker told him to drink more water and to take a rest, but he continued to work because he was afraid he would not finish the task. After another hour, he was too dizzy to continue working. He was taken to the clinic in town, where the physician asked the worker's supervisor some questions and, after looking up the toxicity of methyl bromide, learned that heat would hasten the volatilization of the gas from the soil. Except for a slightly increased heart rate, the worker's physical examination was normal. Blood tests showed slight electrolyte abnormalities. The doctor diagnosed the worker as having either mild methyl bromide poisoning or heat exhaustion. The doctor called the closest major laboratory several hours away and found that it would take at least a week to obtain the results of a blood sample for methyl bromide levels. He called the regional poison control center, which told him that there was no specific treatment for mild methyl bromide intoxication. He decided to treat the worker for mild heat exhaustion and had the health educator explain to the worker, in Spanish, the need for frequent rest breaks and good hydration when working in extreme heat and about ways of recognizing and preventing pesticide exposure.*

Some industries pose especially complex challenges for occupational and environmental health professionals due to the variability of exposures and the high mobility of the workforce. In these industries, where workers perform a variety of tasks as they are exposed to many different hazards, it can be difficult to determine which exposure, if any, is responsible for a worker's health complaint. Sometimes, as in the above case, multiple exposures may interact, making diagnosis, treatment, and prevention especially difficult. Although knowledge of the health effects of individual hazards is important, occupational and environmental health professionals need to appreciate the complex ways in which workers experience these hazards and how the dynamic characteristics of industry can challenge their ability to control exposures and resultant health effects. In this chapter, we describe three important industries where workers face many hazards and where job mobility and task variability make assessment and control of hazards challenging.

Although fictitious, this case was derived from the experience of Dr. Rupali Das, Director of the Pesticide Illness Surveillance Program at the Occupational Health Branch of the California Department of Health Services.

AGRICULTURAL WORKERS

Sherry L. Baron

Worldwide, more people work in agriculture than in any other industry, with most engaged in labor-intensive, small-scale subsistence farming. In the United States, although agriculture is dominated by larger and more mechanized production, farm work remains one of the most labor-intensive and lowest paid occupations. The broad occupational category of farmworker includes both family farmers who work on their own farms and hired farmworkers. Although this chapter focuses on the approximately 2 million hired farmworkers, family farm owners face many of the same classes and combinations of hazards.

In the United States, 84 percent of hired farmworkers are Hispanic and 79 percent were born in Mexico.[1] One-third of the foreign-born workers are recent immigrants who have worked in the United States for 2 years or less; many are living apart from their families and experiencing social isolation that creates additional stress. Farmworkers are younger (average age of 31) than the general workforce and most (79 percent) are men. Most have a very low literacy level, which can have significant impact on their ability to read warning labels or understand safety instructions. Only 22 percent of workers can read and write English well and more than half have less than an eighth grade education. For the many who come from rural areas of Mexico, where an indigenous language is spoken, Spanish is their second and English would be their third language.

Forty-two percent of farmworkers face additional stress because of their needs to migrate for work and live temporarily away from their homes, often in crowded and inadequate housing. Hired farmworkers, on average, only work in agriculture about 8 months of the year. Due to low wages and extended periods of unemployment, for more than half of hired farmworkers family income is less than $15,000 per year. Fifty-three percent are not legally authorized to work in the United States; therefore, they may be vulnerable to abuse and are unlikely to report mistreatment.

Occupational Exposures

In 1960, Edward R. Murrow's classic documentary, *Harvest of Shame*, shocked viewers by depicting the deplorable working conditions of farmworkers in the United States. Nonetheless, little attention was paid toward improving safety and health conditions for agricultural workers until relatively recently. In 1991, the Surgeon General convened a national meeting on the health of agricultural workers, and subsequently the National Institute for Occupational Safety and Health (NIOSH) established a network of research centers to improve health and safety of family farmers and hired farmworkers. In 1995, NIOSH convened a special panel to make recommendations on the priority occupational health problems for hired farmworkers.[2] This panel selected nine priority health outcomes as a focus for future research and intervention (Table 32-1). The most common of these occupational health problems are discussed in more detail below.

Musculoskeletal Conditions

From strawberry pickers harvesting crops in a sustained stooped posture to citrus pickers carrying heavy sacks up ladders while reaching for the next orange, farm work is associated with a variety of musculoskeletal disorders (Fig. 32-1). In addition, because one-fifth of farmworkers are paid based on the quantity of crops harvested (piece rate), in many work settings there are economic incentives for them to maintain a rapid, sustained work pace. About one-half of all agricultural injuries requiring time away from work are musculoskeletal injuries, such as sprains, strains, and injuries causing low back pain. To prevent such injuries, some research centers are developing innovative, low-cost methods of improving the ergonomic design of farm work, such as a redesigned tool to carry potted plants (Fig. 32-2).

Pesticide-Related Illness

Pesticide-related illness refers to a broad group of health outcomes, including dermatitis, cancer, eye injuries, and respiratory diseases. Although many research studies have been conducted on the toxicology and health effects of pesticides, few of these studies have been directed at the hired farmworker population. There is no national surveillance system to accurately record the national incidence or prevalence of pesticide-related illnesses that occur in the farm sector. California, which employs about one-third of all farmworkers in the United States, is one of the few states with a mandatory reporting system for occupational pesticide intoxications. Its data provide useful information on the nature of

TABLE 32-1

Selected Hazards, Health Effects, and Control Strategies in Agriculture

Health Effect	Hazard	Control Strategy
Musculoskeletal disorders	Prolonged stooping, heavy lifting, repetitive movements of the upper extremities during planting, pruning, and harvesting	Ergonomic reengineering of tools and workplace; decrease of weight of the loads; job rotation among repetitive and nonrepetitive tasks
Pesticide-related conditions	Mixing, loading, and applying pesticides; working in fields recently sprayed with pesticides; aerial drift of pesticides from adjacent fields; exposure to pesticides in living quarters	Substitution of less toxic substances; adequate protective equipment; training on prevention of pesticide exposures; administrative restrictions on working in fields where exposure may occur
Traumatic injuries	Work-related incidents with tractors and other farm equipment; motor vehicle crashes during transport to and from the fields; lacerations from sharp tools for cutting and pruning	Use of roll-over protection systems in tractors; training and enforcement of safe use of equipment; transportation vehicles equipped with personal restraint systems; safe cutting tools
Respiratory conditions	Airborne exposure to allergic and irritant substances, either naturally occurring in the soil and crops or due to chemical substances	Substitution of less toxic materials; use of respirators, if indicated; administrative controls to remove sensitized workers from exposure
Dermatitis	Skin contact with allergic and irritant substances, either naturally occurring in the soil and crops or in fertilizers and pesticides	Substitution of less toxic materials; use of gloves and sleeves, if indicated; administrative controls to remove sensitized workers from exposure
Infectious diseases	Inadequate sanitation facilities; exposure to tuberculosis, sexually transmitted diseases, and other infectious diseases due to living arrangements of migrant workers	Improved sanitation facilities; improved housing facilities; improved health care screening and treatment services
Cancer	Exposure to chemical substances in pesticides and other agricultural products; prolonged sun exposure	Substitution for less hazardous substances; protective clothing and sunscreen; administrative controls to limit exposure
Eye conditions	Exposure to dusty conditions; foreign bodies from plant material penetrating the eye	Use of protective eye wear; dust control
Mental disorders	Long working hours; inadequate pay; social isolation from family and friends	Improved working and housing conditions; availability of mental health services

farmworkers' exposures to pesticides (Table 32-2). Most overexposures do not occur in those who are applying pesticides but instead to workers who are inadvertently exposed to pesticides while performing routine farm tasks, such as harvesting and weeding. These overexposures commonly occur when pesticides being sprayed on one field drift into the breathing zone of farmworkers in nearby fields or when workers handle crops covered with pesticide residues.[3] Although less than one-third of pesticide poisoning cases lead to lost time from work, given the economic insecurity of most farmworkers, it is difficult to determine if this reflects the affected workers' need to continue working rather than the mild severity of most cases.

Traumatic Injuries

Agriculture is considered one of the most hazardous industries for occupational injuries and deaths.

FIGURE 32-1 • Farmworkers carrying buckets of tomatoes to be counted. These workers are paid based on the numbers of tomatoes they pick, which encourages them to work fast and carry very heavy loads. Bending and carrying heavy loads can cause musculoskeletal disorders. (Photograph by David Bacon.)

Agriculture has an occupational fatality rate comparable to the mining industry with close to 23 fatalities per 100,000 workers. In 2003, the fatality rate in agriculture was almost twice the rate in both the construction and transportation industries. About one-half of all agricultural fatalities occur as a result of transportation accidents, primarily related to tractors. The use of new roll-over protective structures on tractors has helped to prevent these fatalities.

FIGURE 32-2 • **(A)** Picking up and carrying large potted plants in this manner increases the risk of low back and upper extremity injuries. **(B)** This device, used as an ergonomic intervention for nursery workers, reduces the need to bend in order to pick up potted plants; it also has a handle designed to decrease stress on the upper extremities. (Courtesy of University of California Davis.)

TABLE 32-1

Characteristics of 486 Farmworker Pesticide Illness Cases Reported to the California Department of Health Services Pesticide Illness Surveillance System during 1998–1999

Characteristics	Number (Percent)
Demographic characteristics	
Hispanic surname	413 (85)
Male	387 (80)
Age, years: mean (range)	35 (13–73)
Organ system affected	
Dermatologic	215 (44)
Ocular	158 (33)
Nervous system	188 (39)
Gastrointestinal	185 (38)
Respiratory	115 (24)
Other	99 (20)
Time lost from work	
Yes	142 (29)
No	235 (48)
Not documented	109 (22)
Activity when illness occurred	
Applying pesticides	116 (24)
Mixing or loading pesticides	23 (5)
Routine activity, primarily field work	313 (64)
Other	12 (3)
Unknown	22 (5)

Adapted from Das R, Steege A, Baron S, et al. Pesticide-related illness among migrant farmworkers in the United States. Int J Occup Environ Health 2001;7:303–12.

The nonfatal occupational injury rate in farmworkers is about 7.5 injuries per 100 workers per year. Because of the lack of mandatory workers' compensation coverage for many agricultural workers and their fear of lost wages, there is probably significant underreporting of work-related injuries. For example, a study in North Carolina, a state that does not have comprehensive workers' compensation for farmworkers, found that 24 (8.4 percent) of 287 workers reported an injury at work in the previous 3 years. Of the 17 injured workers who considered medical attention necessary, 41 percent did not receive it within 24 hours, and 24 percent never received it. The most common reason why workers did not receive medical attention was refusal by their supervisors for them to leave work or lack of transportation. Medical expenses were paid for by employers for only 38 percent of injuries.[4]

Dermatitis

Dermatitis among agricultural workers has been associated with exposures to (a) a variety of chemical agents including pesticides; (b) sensitivity to plant materials, such as poison ivy and poison oak; and (c) infectious agents. In 2002, agricultural workers had the highest reported incidence rate of cases of dermatitis—more than twice that of manufacturing workers. Dermatitis is one of the major health problems associated with pesticide exposure (Table 32-2). A study at four clinics located along the Midwest migrant stream found that for men ages 20 to 29, dermatitis was the primary cause of clinic visits and, for men ages 30 to 44, dermatitis was second only to hypertension-related visits. The rate of dermatitis among these farmworkers was 2.5 times that of the general population.[5]

Children in Agriculture

Agricultural work is one of the most common forms and also the most dangerous form of child labor. In the United States, more than 2 million youths under age 20 are potentially exposed to agricultural hazards each year including farm residents, farmworkers, children of migrant or seasonal workers, and farm visitors (Fig. 32-3).[6] Although many of these youths are paid or unpaid children of family farmers, an increasingly important group of hired farmworkers are self-emancipated minors, who are primarily unauthorized recent immigrants living and working away from their families. These workers are especially vulnerable to injury because of their age, their undocumented legal status, and their social isolation from friends and family (see Chapter 31).

In 1998, there were about 33,000 injuries to children on farms in the United States. The primary causes of injury were falls and incidents involving animals and farm vehicles. Between 1982 and 1996, there were more than 2,000 farm deaths in children under age 20—almost half in children under age 10. The most common causes of deaths were machinery accidents, such as from tractors, and drowning.

FIGURE 32-3 ● Toddlers play in the rows of a field of green onions while their parents work. (Photograph by David Bacon.)

Federal child labor laws, which regulate working conditions for minors, have many dual standards that provide lesser protection for children employed in agriculture than children employed in other industries, including:

- The minimum permissible work age is 14 in agriculture and 16 in other industries.
- Children ages 12 or 13 may work in agriculture with the consent of their parents.
- Work tasks that have been designated as hazardous by the federal government can be done at age 16 in agriculture but not until age 18 in other industries.

In 1996, a national coalition of organizations issued a National Action Plan entitled "Children and Agriculture: Opportunities for Safety and Health," which led to special congressional funding to improve research and prevention of child agricultural injuries. One of the major accomplishments of this initiative has been the creation of the North American Guidelines for Children's Agricultural Tasks, which, in the absence of laws to restrict hazardous work tasks for youth, created voluntary guidelines to assist adults in assigning age-appropriate tasks to children ages 7 to 16. These guidelines primarily focus on educating family farmers and influencing their decisions about which farm tasks their children can safely perform.[7]

Federal Regulations and Health Services Programs for Farmworkers

Most federal occupational health laws are less protective of agricultural workers than other industrial workers. Many Occupational Safety and Health Administration (OSHA) standards, such as the Hazard Communication Standard and protections against electrocutions and unguarded machinery, explicitly exclude agricultural workers. In addition, OSHA is prohibited from regulating farms with fewer than 11 employees. The OSHA regulations targeting agriculture include the Field Sanitation Standard, which requires drinking water, handwashing water, and toilets in the fields; regulations that require rollover protective structures (ROPS) in tractors manufactured after 1976; and regulations concerning housing conditions in temporary labor camps operated by agricultural employers.

Occupational pesticide exposure is unique in that it is the only occupational exposure that is entirely regulated by the Environmental Protection Agency (EPA). In 1992, under the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA),

EPA promulgated the Worker Protection Standard. This federal regulation governs the use of agricultural pesticides used for commercial production purposes. Its worker health and safety provisions require mandatory training programs, enforcement of pesticide reentry intervals, and provision of decontamination washing facilities. The enforcement of this standard, which is implemented by cooperative agreements between EPA and state agencies, has been criticized as being inadequate, in part because of the limitation of FIFRA to impose penalties against employers.

Under the Migrant Health Act of 1962, the federal government provides support to more than 120 community-based and state organizations that offer comprehensive primary care services to address the unique needs of hired farmworkers. As a result of this program, a network of migrant health clinics has been created that improves the provision of health care services for this unique worker population. However, significant obstacles still exist due to cultural, linguistic, and logistical barriers that result in many farmworkers lacking adequate health coverage (Box 32-1).

BOX 32-1

Farmworker Health in a Binational Context

Rick Mines

We walked up to the second story of a paint-deprived wooden apartment building on the outskirts of Salinas, California. The flat had two small bedrooms and a living room/kitchen combination. Furniture was scarce but clean. Cesar, 29, lived there with his wife and three small children. Cesar had come from a small town in southern Zacatecas for the first time about 10 years before. In the town, he had finished primary school and then worked helping his father plant corn, beans, and squash. He also had worked as a sharecropper for a neighbor planting hot chilis on irrigated land and worked tending cattle. But, like most young people from the town, he decided to follow his relatives and friends north to the Salinas area. He had come and gone from his hometown many times in the early years during the 10 years, working mostly in the lettuce and cabbage fields. His wife came across the border 4 years ago; two of his three children were born in Salinas. Cesar is lucky; he has a work permit and is waiting for his green card.

Cesar feels like he is doing pretty well. He gets about 8 months a year of work in the fields and earns about $15,000 a year. However, when the topic turned to the asthmatic condition of his son Salvador, his mood changed abruptly. He launched into an angry condemnation of the medical system in California. He had taken Salvador to many doctors, but no one really helped. They went to the clinic where they waited a long time to be seen. Finally, the doctor saw them. But, he did not speak Spanish well enough to communicate so they did not understand what he said. But, the worst part is that he did not give them any medicine to cure Salvador. They went back several times to see the doctor who asked for several laboratory tests, all of which were very expensive. Finally, after many visits, he was given some medicine that did not work. Cesar is sure that the doctor is just trying to make money by delaying treatment, calling for tests, and charging money for everything. Cesar is now saddled with medical debt because of his interaction with this doctor. Cesar ended up taking his son back to Mexico where he got medicine that works. Cesar is furious and is convinced that the U.S. doctors are just a bunch of charlatans making money off poor Mexican immigrants.

The Binational Farmworker Health Survey (BFHS)

Why are Cesar and so many other farmworkers so angry about the treatment they get in our medical system? What is it about the system or about them that makes the relationship such a difficult one? To answer that question, we carried out a binational survey that took place partly in rural Zacatecas and partly in various settlement communities in the United States. By going to the place of origin, we hoped to get some insight into this challenging conflict.

It was found that the experience of the farmworker immigrant population with health care is extremely different in their home areas. Almost all farmworkers come to the United States after already having been raised in rural or small town Mexico. This very contrasting formative experience makes for a very difficult adaptation to institutions in the United States. In the farmworkers' hometowns, medical practitioners ("medicos") do not have doctoral

(continued)

BOX 32-1

***Farmworker Health in a Binational Context** (Continued)*

degrees. They go straight from high school to medical school and begin practicing after getting a bachelor's degree. In the small towns, several of them set up consultation offices directly connected to pharmacies. The incentive for these medicos/pharmacists is to sell medicine as a useful source of income. The medicos keep no or few records about patients, give quick service, and usually provide quick treatment in the form of shots and pills. There are few laboratory tests done and diagnosis is done on the spot. However, the medicos have excellent rapport with their patients. Many are known as being extremely skilled—if a bit intuitive—diagnosticians. They are willing to allow a mix of traditional healing practices with their modern medical techniques. And they speak the same language of the people and share their sense of humor and cultural approach to solving problems.

When the Mexicans come north, they are faced with a totally different environment. The paperwork—a totally new experience—is overwhelming for a poorly educated group. The long waits, their treatment by intake staff (who may feel contemptuous of the workers even if they speak some Spanish), frequent testing, and, above all, the relative timidity of U.S. physicians about prescribing strong medicines leaves the farmworkers extremely confused and often angry.

The solution to this deep cultural clash probably does not lie in spending much money on extra care for the immigrants; it lies in designing institutions that provide immigrant farmworkers with alternatives more similar to their formative experience.

CONSTRUCTION WORKERS

Laura S. Welch

Construction workers build, repair, renovate, modify, and demolish structures: houses, office buildings, temples, factories, hospitals, roads, bridges, tunnels, stadiums, docks, airports, and more. Construction work is composed of many different tasks undertaken by many different trades. To understand the risk for injury and illness, one must understand the work of specific trades and their characteristic tasks (Table 32-3).

Construction often must be done in extreme heat or cold; in windy, rainy, snowy, or foggy weather; or at night. Intermittent and seasonal work adds to the health risks and stress of job insecurity. Episodic employment, frequent changes of employer, and continuous changes in worksite exposures and ambient conditions make it difficult to document workers' jobs and hazardous exposures. Because of these factors, some of which are unique to construction, data on the extent or effect of toxic exposures in the construction industry is limited.

In industrialized nations, construction is consistently ranked among the most dangerous occupations. In the United States, 19 percent of all fatal on-the-job injuries occur in construction—about three times its 6 percent share of the total employment. One-half of all fatal falls occur in construction. For nonfatal injuries, in 2001 there were 4 lost workday cases per 100 full-time equivalent construction workers, a rate exceeding all other sectors. Leading causes of injuries with days away from work among construction workers in 2001 were contact with objects (34 percent), falls (21 percent), and overexertion (20 percent). Leading specific diagnoses were strains and sprains (38 percent), cuts and lacerations (12 percent), fractures (11 percent), and bruises and contusions (7 percent).[8]

The annual costs of occupational injuries in all industries in the United States is an estimated $40 billion in direct costs and $131 to $145 billion when indirect costs are included. (Few of the costs for occupational diseases are included in these estimates.) Construction injuries comprise a disproportionate share of the total. In 2000, the average level of workers' compensation injury payments for construction was $7,542—nearly double the level for all industries. In 2002 in Washington State, 27 percent of all costs to the state's workers' compensation fund were from injured construction workers, although construction represented only 6 percent of the workforce. As an indicator of costs, workers' compensation premiums had a median cost of

TABLE 32-3

Construction Occupations and Tasks

Boilermakers	Construct, assemble, maintain, and repair stationary steam boilers and boiler house auxiliaries. Work involves use of hand and power tools, plumb bobs, levels, wedges, dogs, or turnbuckles. Assist in testing assembled vessels. Direct cleaning of boilers and boiler furnaces. Inspect and repair boiler fittings, such as safety valves, regulators, automatic-control mechanisms, water columns, and auxiliary machines.
Brickmasons	Lay and bind building materials, such as brick, structural tile, concrete block, cinder block, glass block, and terra-cotta block, with mortar and other substances to construct or repair walls, partitions, arches, sewers, and other structures.
Carpenters	Construct, erect, install, or repair structures and fixtures made of wood, such as concrete forms; building frameworks, including partitions, joists, studding, and rafters; wood stairways, window and door frames, and hardwood floors. May also install cabinets, siding, drywall, and batt or roll insulation
Carpet installers	Lay and install carpet from rolls or blocks on floors. Install padding and trim flooring materials.
Cement masons and concrete finishers	Smooth and finish surfaces of poured concrete, such as floors, walks, sidewalks, roads, or curbs using a variety of hand and power tools. Align forms for sidewalks, curbs, or gutters; patch voids; use saws to cut expansion joints.
Construction laborers	Perform tasks involving physical labor at building, highway, and heavy construction projects, tunnel and shaft excavations, and demolition sites. May operate hand and power tools of all types: air hammers, earth tampers, cement mixers, small mechanical hoists, surveying and measuring equipment, and a variety of other equipment and instruments. May clean and prepare sites, dig trenches, set braces to support the sides of excavations, erect scaffolding, clean up rubble and debris, and remove asbestos, lead, and other hazardous waste materials.
Drywall and ceiling tile installers	Apply plasterboard or other wallboard to ceilings or interior walls of buildings. Apply or mount acoustical tiles or blocks, strips, or sheets of shock-absorbing materials to ceilings and walls of buildings to reduce or reflect sound. Materials may be of decorative quality. Include lathers who fasten wooden, metal, or rockboard lath to walls, ceilings or partitions of buildings to provide support base for plaster, fire-proofing, or acoustical material.
Electricians	Install, maintain, and repair electrical wiring, equipment, and fixtures. Ensure that work is in accordance with relevant codes. May install or service street lights, intercom systems, or electrical control systems
Insulation workers	Apply insulating materials to pipes or ductwork or other mechanical systems in order to help control and maintain temperature. Also line and cover structures with insulating materials. May work with batt, roll, or blown insulation materials
Operating engineers	Operate one or several types of power construction equipment, such as motor graders, bulldozers, scrapers, compressors, pumps, derricks, shovels, tractors, or front-end loaders to excavate, move, and grade earth, erect structures, or pour concrete or other hard surface pavement. May repair and maintain equipment in addition to other duties.
Painters	Paint walls, equipment, buildings, bridges, and other structural surfaces, using brushes, rollers, and spray guns. May remove old paint to prepare surface prior to painting. May mix colors or oils to obtain desired color or consistency.
Paperhangers	Cover interior walls and ceilings of rooms with decorative wallpaper or fabric, or attach advertising posters on surfaces, such as walls and billboards. Duties include removing old materials from surface to be papered.

(*continued*)

TABLE 32-3 Continued

Construction Occupations and Tasks

Plumbers, pipefitters, and steamfitters	Assemble, install, alter, and repair pipelines or pipe systems that carry water, steam, air, or other liquids or gases. May install heating and cooling equipment and mechanical control systems.
Plasterers and stucco masons	Apply interior or exterior plaster, cement, stucco, or similar materials. May also set ornamental plaster.
Reinforcing iron and rebar workers	Position and secure steel bars or mesh in concrete forms in order to reinforce concrete. Use a variety of fasteners, rod-bending machines, blowtorches, and hand tools. Includes rod busters.
Roofers	Cover roofs of structures with shingles, slate, asphalt, aluminum, wood, and related materials. May spray roofs, sidings, and walls with material to bind, seal, insulate, or soundproof sections of structures.
Sheet-metal workers	Fabricate, assemble, install, and repair sheet-metal products and equipment, such as ducts, control boxes, drainpipes, and furnace casings. Work may involve any of the following: setting up and operating fabricating machines to cut, bend, and straighten sheet metal; shaping metal over anvils, blocks, or forms using hammer; operating soldering and welding equipment to join sheet-metal parts; inspecting, assembling, and smoothing seams and joints of burred surfaces. Includes sheet-metal duct installers who install prefabricated sheet-metal ducts used for heating, air conditioning, or other purposes.
Stonemasons	Build stone structures, such as piers, walls, and abutments. Lay walks, curbstones, or special types of masonry for vats, tanks, and floors.
Structural iron and steel workers	Raise, place, and unite iron or steel girders, columns, and other structural members to form completed structures or structural frameworks. May erect metal storage tanks and assemble prefabricated metal buildings.
Terrazzo workers and finishers	Apply a mixture of cement, sand, pigment, or marble chips to floors, stairways, and cabinet fixtures to fashion durable and decorative surfaces
Tile and marble setters	Apply hard tile, marble, and wood tile to walls, floors, ceilings, and roof decks.

Source: Bureau of Labor Statistics, Standard occupational classification manual, 1998 revision. Available at <http://stats.bls.gov/soc/socguide.htm>.

more than $30 per hour worked for ironworkers and roofers. In addition to worker's compensation, there are liability insurance premiums and other indirect costs, including (a) reduced work crew efficiency; (b) clean-up costs, such as from a cave-in or collapse; and (c) overtime costs necessitated by an injury.[9]

Occupational diseases are also an important cause of morbidity in construction workers. Table 32-4 summarizes sentinel health events that may occur in construction workers and specific exposures that can lead to these diseases. These hazardous exposures include air contaminants such as wood dust, abrasive blasting dust, gypsum and alkaline dusts, silica, asbestos, lead, diesel exhaust, and welding fumes.

Lead

Lead exposure and lead toxicity are particularly important problems in the construction industry. Excessive lead exposures are associated with several construction tasks.[10] Nearly 1 million U.S. construction workers are exposed to lead on the job; more than 80 percent of these workers are involved in commercial or residential remodeling. However, before 1993, the OSHA lead standard applied only to general industry, not to construction. In 1992, blood lead levels (BLLs) in bridge construction workers ranged from 51 to 160 μg/dL, with 62 percent of elevated BLLs involving work in a containment structure. High-risk activities associated with lead dust and

TABLE 32-4

Sentinel Health Events in Construction and Illustrative Examples

Condition	Industry/Process/Occupation	Agent
Asbestosis	Asbestos industries and users	Asbestos
Bronchitis (acute), pneumonitis, and pulmonary edema due to fumes and vapors	Arc welders, boilermakers	Nitrogen oxides Vanadium pentoxide
Chronic or acute renal failure	Plumbers	Inorganic lead
Contact and allergic dermatitis	Cement masons and finishers, carpenters, floorlayers	Adhesives and sealants, irritants (such as cutting oils, phenol, solvents, acids, alkalis, detergents); allergens (such as nickel, chromates, formaldehyde, dyes, rubber products).
Extrinsic asthma	Wood workers, furniture makers	Red cedar (plicatic acid) and other wood dusts
Histoplasmosis	Bridge maintenance workers	*Histoplasma capsulatum*
Inflammatory and toxic neuropathy	Furniture refinishers, degreasing operations	Hexane
Malignant neoplasm of scrotum	Chimney sweeps	Mineral oil, pitch, tar
Malignant neoplasm of nasal cavities	Wood workers, cabinet and furniture makers, carpenters	Hardwood and softwood dusts Chlorophenols
Malignant neoplasm of trachea, bronchus, and lung	Asbestos industries and users	Asbestos
Malignant neoplasm of nasopharynx	Carpenters, cabinetmakers	Chlorophenols
Malignant neoplasm of larynx	Asbestos industries and users	Asbestos
Mesothelioma (malignancy of peritoneum and pleura)	Asbestos industries and users	Asbestos
Noise effects on inner ear	Occupations with exposure to excessive noise	Excessive noise
Raynaud's phenomenon (secondary)	Jackhammer operators, riveters	Whole body or segmental vibration
Sequoiosis	Red cedar mill workers, wood workers	Redwood sawdust
Silicosis	Sandblasters	Silica
Silicotuberculosis	Sandblasters	Silica + *Mycobacterium tuberculosis*
Toxic encephalitis	Lead paint removal	Lead
Toxic hepatitis	Fumigators	Methyl bromide

Adapted from Mullan R, Murthy L. Occupational sentinel health events: An up-dated list for physician recognition and public health surveillance. Am J Ind Med 1991;19:775–99.

fumes among bridge and structural steel workers include abrasive blasting, sanding, burning, cutting or welding on steel structures coated with lead paint, and using containment enclosures. The 1993 OSHA lead standard incorporates a presumption of exposure during specific high-risk tasks and requires specific protections during these tasks, unless air monitoring demonstrates exposure below the permissible exposure limit (PEL). However, the OSHA standard may not fully protect construction workers from lead toxicity. The standard requires monitoring every 2 months, but some tasks, such as burning lead-coated steel, can cause a rapid rise in BLL. Thus, more frequent monitoring and a lower threshold for mandated industrial hygiene inspection or medical removal has been recommended in some circumstances.

Noise

Construction workers generally have excessive noise exposures and high rates of noise-induced hearing loss. More than 500,000 construction workers are exposed to potentially hazardous levels of noise. The United States has a different standard for regulation of noise exposure in construction than in general industry; in the construction standard, there is no action level above which a hearing conservation program is required, and there are no detailed requirements for training or record keeping. Yet the work is very noisy. For example, a laborer using a heavy-duty bulldozer is exposed to 91 to 107 dBA, with a mean of 99 dBA. Exposure in crane cabs ranges from a mean of 81 dBA in insulated cabs to 97 dBA in those without insulation, but there is little to no medical monitoring. Models for improvement exist. British Columbia implemented a specific hearing conservation program in construction in 1987. Since that time, reported use of hearing protection has increased from 55 to 85 percent of workers surveyed, and the proportion of construction workers age 50 to 59 with a hearing handicap has dropped from 36 to 25 percent. This program clearly demonstrates the feasibility and efficacy of a hearing conservation program.[11]

Musculoskeletal Disorders

Soft-tissue musculoskeletal injuries make up a high proportion of all work-related injuries in construction[12] (Fig. 32-4). In 2001, there were in the United States an estimated 185,700 injuries and illnesses with lost workdays in construction: 21 percent of these injuries were attributable to overexertion and 21 percent were injuries to the low back. The rates for these injuries are considerably higher in construction than in all private industry combined.[13] Construction workers retire 2 years earlier than the average worker, often because of musculoskeletal conditions, such as arthritis and degenerative disc disease.

Construction workers have a high prevalence of chronic musculoskeletal complaints, such as pain, aches, and discomfort. For example, about half of the electricians in one study had back and hand or wrist symptoms; more than 80 percent had symptoms in the prior year that lasted more than a week or recurred at least three times, and more than 60 percent reported symptoms in two or more body areas.

In 1998, 10 percent of construction workers in the United States reported back pain due to repeated injury at work—twice the rate of all workers. Severe hand discomfort was present in almost 16 percent of construction workers compared to 11 percent of all workers. Strains and sprains are the leading compensable injury for construction workers. (See also Chapter 23).

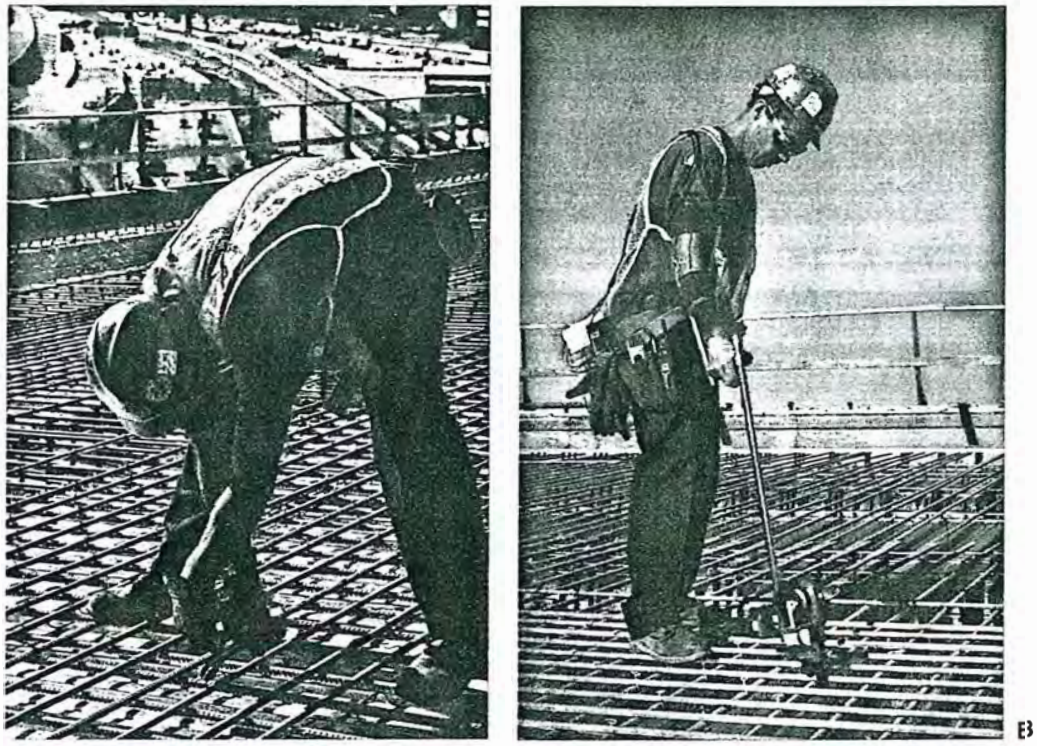
Respiratory Diseases

Construction workers are exposed to a variety of respiratory hazards, including asbestos, silica, synthetic vitreous fibers, cadmium, chromates, formaldehyde, resin adhesives, cobalt, metal fumes, creosote, gasoline, oils, diesel fumes, paint fumes and dusts, pitch, sealers, solvents, wood dusts and wood preservatives, and excessive cold.[14]

Surveillance data on occupational respiratory disease among construction workers are limited. In the United States, respiratory conditions account for 14 percent of the approximately 7,000 reported occupational illness cases among construction workers each year. Their relative risk for both lung cancer and emphysema is 1.3, suggesting a 30 percent excess due to occupational exposures.

Asbestosis

Asbestos has been recognized as a respiratory hazard for several construction trades. Occupational exposure to asbestos with resultant asbestosis occurs in many construction workers, especially insulators, plumbers and pipefitters, electricians, and



A B

FIGURE 32-4 • **(A)** Construction workers are at increased risk of upper extremity and back strain. **(B)** An ergonomically designed device decreases the upper extremity and back strain on construction workers who are tying rebar. (Photographs by Earl Dotter.)

sheet-metal workers. Any construction worker may be at risk for asbestos-induced disease resulting from exposure associated with working near insulation. Although asbestos is no longer used in new residential or heavy construction, workers may continue to be exposed to previously installed asbestos during maintenance, renovation, addition, or demolition activities.

Silicosis

Occupational exposure to silica can occur among various types of construction workers, including those employed in concrete removal and demolition work, bridge and road construction, tunnel construction, and concrete or granite cutting, sanding, and grinding. Sandblasters are at increased risk from exposure to crystalline silica. Those working nearby on the same construction site may also be at risk from silica-related disease. In the United States, sand containing crystalline silica is still used in abrasive blasting operations for maintenance of structures, preparing surfaces for painting, and in forming decorative patterns during installation of building materials; these uses of sand have been banned in many other countries. Silica exposures in the construction industry in the United States continue to exceed recommended limits. Silicosis continues to occur in construction workers worldwide.

Chronic Obstructive Pulmonary Disease and Asthma

Chronic obstructive pulmonary disease (COPD) has been reported among construction workers exposed to asbestos, synthetic vitreous fibers, and welding fumes. Occupations at risk are spray painters, welders, tunnel construction workers, construction painters, and sheet-metal workers. Chronic nonspecific lung disease symptoms are increased among construction workers, woodworkers, and painters even after adjusting for smoking and age. Specific exposures associated with excess risk of chronic nonspecific lung disease include heavy metals, mineral dust, and adhesives. Construction workers can

be exposed to many agents that can cause asthma and to cold, various particulates, dusts, fumes, and irritants, all of which can exacerbate underlying asthma. (See also Chapter 25).

Dermatitis

Construction workers are exposed to many chemicals that cause irritant or allergic dermatitis. Portland cement, found in plaster and in concrete mixes, is extremely alkaline. Wet plaster also contains slaked lime, or calcium hydroxide, which is even more caustic. In addition, Portland cement contains trace amounts of hexavalent chromium, a strong sensitizing agent responsible for allergic contact dermatitis in cement workers. Other sensitizing agents include epoxy adhesives, sealants, and chemicals mixed within cement and plaster. Rubber gloves also may cause allergic dermatitis.

One way to prevent allergic contact dermatitis in cement workers is to add ferrous sulfate. When ferrous sulfate is combined with hexavalent chromium in cement, it forms an insoluble trivalent compound when water is added; trivalent chromium is not easily absorbed by skin. In several Scandinavian countries where this is required by law, allergic contact dermatitis has been prevented in cement workers.

Cancer

Construction workers are exposed to many carcinogens (Table 32-5). Insulators, painters and plasterers, sheet-metal workers, and other construction workers are at increased risk of lung cancer. Woodworkers, cabinetmakers, and furniture makers as well as carpenters and joiners have an increased risk of nasal cancer. Excess rates of mesothelioma have been well documented in many trades after widespread exposure to asbestos from 1940 to 1980. Given the long latency period for mesothelioma, asbestos-related cases are likely to occur for many years to come.

TABLE 32-5

Epidemiology of Lung Cancer in Construction Workers

Trade	Known Lung Carcinogens
Insulators	Asbestos
Painters and plasterers	Chromium, cadmium, asbestos
Sheet-metal workers	Asbestos, welding fume
Welders	Welding fume, asbestos, hexavalent chromium
Masons	Asbestos, hexavalent chromium, silica
Electricians	Asbestos
Plumbers and pipefitters	Asbestos, welding fume
Roofers	Coal tar, bitumen, PAHs
Carpenters	Wood dust

REGULATIONS AND HEALTH SERVICES FOR CONSTRUCTION WORKERS

Construction workers are often not covered by the OSHA regulations that cover manufacturing and service sectors. For example, the standard for noise exposure for the construction industry has no action level above which a hearing conservation program is required and no detailed requirements for training or record keeping. The OSHA lead standard did not apply to the construction industry until 1993, although many lead poisoning cases in the state lead registries were in construction workers. The rationale for separate OSHA standards for construction was that controls that work in general industry may not work in construction, and therefore feasibility of a standard had to be demonstrated specifically in construction before the standard was applied to the construction sector. Although this is a reasonable consideration, leaving construction out of a standard until feasibility was demonstrated led to decades of hazardous exposure for construction workers. Underreporting of injury and illness is prevalent in construction because the construction industry is composed mainly of small employers. A requirement to report injury by construction project, which may include many small employers, could help to better elucidate and focus more attention on these problems.

In the United States, intermittent employment and the high cost of health insurance can leave construction workers and their families without health care coverage. Even when construction workers work the 30 or 60 days frequently needed on a job to qualify for health insurance coverage, the high cost of coverage leaves many uninsured. Because

construction is a complex industry, there are proportionately fewer research and prevention activities in construction than in general industry. All of these circumstances leave the construction industry in great need for improvement in health and safety.

HEALTH CARE WORKERS

Jane A. Lipscomb

More than 10 percent of workers in the United States are health care workers. Characterized as people committed to promoting health through treatment and care for the sick and injured, health care workers, ironically, confront perhaps a greater range of significant workplace hazards than workers in any other sector. Hazards facing health care workers include:

- Biological hazards associated with airborne contact and blood-borne exposures to infectious agents (Fig. 32-5);
- Chemical hazards, especially those found in hospitals, including waste anesthetic and sterilant gases, hazardous drugs (such as antineoplastic medications) and other therapeutic agents, mercury, and industrial-strength disinfectants and cleaning compounds;
- Physical hazards, including ionizing and nonionizing radiation;
- Safety and ergonomic hazards that can lead to a variety of acute and chronic musculoskeletal problems;
- Violence;
- Psychosocial and organizational factors, including psychologic stress and shift work; and
- The many health consequences associated with changes in the organization and financing of health care (Table 32-6).

FIGURE 32-5 • Health care workers can be protected from tuberculosis by proper isolation treatment of patients, use of enclosures, exhaust ventilation, and germicidal lamps. The last line of defense is the use of personal respiratory protection, one example of which (a powered air-purifying respirator) is illustrated above. (Courtesy of the National Institute for Occupational Safety and Health.)

In 2002, the Bureau of Labor Statistics (BLS) injury and illness rate among hospital workers (9.7 per 100 workers) was nearly double that of the overall private sector rate (5.3) and higher than rates for workers employed in mining (4.0), manufacturing (7.2), and construction (7.1). Although injury and illness rates have been declining among all private sector workers, the ratio of hospital worker injuries to the overall private sector rate has increased over the past 6 years.

The nursing home segment of the health care industry has consistently reported injury and illness rates significantly higher than those for the most hazardous industries—as high as 12.6 per 100 full-time workers in 2002. In health care, workers as well as patients are affected when occupational safety and health threats are not adequately identified and addressed. Nonetheless, the health care industry is a decade or more behind other high-risk industries in ensuring safety.

The generation and disposal of biological chemical, and radiologic wastes also pose risks to the communities surrounding health care facilities and beyond, especially if these facilities incinerate their waste on site. The widespread use and resulting incineration of plastics containing chloride compounds, such as polyvinyl chloride, have the potential to create and release into the atmosphere dioxins, which are highly toxic. Community organizations have successfully advocated for changes, such as the phasing out of products that contain mercury within the health care setting and a reduction in the incineration of mercury-containing products. In 1998, the American Hospital Association

TABLE 32-6

Selected Hazards, Health Effects, and Control Strategies in Health Care

Hazards	Health Effects	Control Strategies
Biological		
Viral (hepatitis B virus, hepatitis C virus)	Acute febrile illness, liver disease, death	Safer needle devices, hepatitis B vaccine
Bacteria (*Mycobacterium tuberculosis*)	TB infection and active disease, multiple drug resistance, death	Isolation of suspect patients, respirators, ultraviolet light, negative pressure rooms
Natural rubber latex proteins (and rubber chemical additives)	Type I and type IV immunologic responses; type I immediate hypersensitivity includes anaphylactic shock	Substitution with low–latex protein, powderless gloves or nonlatex gloves and supplies
Chemical		
Ethylene oxide	Peripheral neuropathy, cancer, reproductive effects	Substitution, enclosed systems, aeration rooms
Formaldehyde	Allergy, nasal cancer	Subsititution, local ventilation
Glutaradehyde	Mucous membrane irritation, sensitization, reproductive effects	Substitution, local ventilation
Antineoplastic drugs	Cancer, mutagenicity, reproductive effects	Class 1 ventilation hoods, isolation of patient excreta
Waste anesthetic gases	Hepatic toxicity, neurologic effects, reproductive effects	Scavenging systems, isolation of off-gassing patients
Mercury	Neurologic effects, birth defects	Substitution with electronic thermometers
Physical		
Patient handling	Back pain, injury	Patient handling devices, lifting teams, training
Static postures	Musculoskeletal pain and injury	Rest breaks, exercise, support hose and shoes
Ionizing radiation	Cancer, reproductive effects	Isolation of patients, shielding and maintenance of equipment
Lasers	Eye and skin burns, inhalation of toxic chemical and pathogens, fires	Local exhaust ventilation, equipment maintenance, respirators and face shields
Physical assault	Traumatic injuries, death	Alarm systems, security personnel, training
Psychosocial/Organizational		
Violence threat and physical assault	Traumatic injury, death, post-traumatic stress disorder	Training, postassault debriefing
Restructuring	Mental health disorders, exacerbation of musculoskeletal injuries, traumatic injuries, burn-out	Acuity-based staffing, employee involvement in restructuring activities
Additional work stress	Mental health disorders, burn-out	Stress prevention and management programs
Shift work	Gastrointestinal disorders, sleep disorders	Forward, stable, and predictable shift rotation

and EPA signed a memorandum of understanding to prevent the release of persistent, bioacculumative toxic chemicals by the industry.

Musculoskeletal Disorders

The highest proportion of musculoskeletal disorders (MSDs), which rank second among all work-related injuries, occur among health care workers. Exposures include the requirements to lift, pull, slide, turn, and transfer patients; move equipment; and stand for long periods of time. Among all occupations, hospital and nursing home workers experience the highest number of occupational injuries and illnesses involving lost workdays due to back injuries. In 2002, nursing home workers experienced a rate of back injuries of 25.9 per 10,000 workers—a rate nearly five times the rate of 5.3 per 10,000 reported among all private-sector industries. Nurses' aides, orderlies, and attendants reported the greatest number of cases of MSDs involving days away from work (44,400).

In a recent survey of nearly 1,200 registered nurses employed in various health care practice settings, nurses reporting highly physically-demanding jobs were five to six times more likely to report a neck, shoulder, or back MSD as compared with those with less physically-demanding jobs. Lifting teams and mechanical devices in the workplace have been associated with significantly lower risk of back MSDs.[15] However, only 10 percent of nurses reported having lifting teams in their workplace and only 50 percent had mechanical lifting devices. The risk for MSDs is also increased when nurses work shifts longer than 12 hours and on evenings, nights, and weekends.[16]

The nursing home industry spends more than $1 billion each year in workers' compensation premiums, even though there is strong evidence that reducing low back load by implementing engineering and administrative controls, such as by safe staffing levels, lifting teams, and use of newer mechanical patient handling devices, reduces the risk of injury to both patients and workers.

MSDs among other occupational groups within the health care industry are less well understood. Laboratory workers are at increased risk for cumulative trauma disorders of the hand and wrist related to repetitive work, such as pipetting. Operating-room workers who must maintain static postures for long periods of time and those involved in overhead work, such as holding instruments overhead during lengthy operations, experience neck and shoulder pain and injury.

Workplace Violence

The health care sector also leads all other industry sectors in the incidence of nonfatal workplace assaults. Of all nonfatal assaults against workers resulting in lost workdays in the United States, 32 percent occurred in the health care sector. In 51 percent of nonfatal assault injuries, the perpetrator of the violent act is a patient. In 2002, the BLS rate of nonfatal assaults among workers in "nursing and personal care facilities" was 18 per 10,000, compared to 3 per 10,000 in the private sector as a whole. Among these assault victims, 30 percent were government employees, even though they make up only 18 percent of the workforce.

In each year from 1993 to 1999, 1.7 million incidents of violence occurred in workplaces in the United States. Twelve percent of all victims reported physical injuries. Six percent of workplace crimes resulted in injury that required medical treatment. Only 46 percent of all incidents were reported to the police. Mental health professionals had an incidence rate of 68 per 1,000 workers compared with an overall rate of 12 per 1,000 workers. Nurses had an incidence rate of 22 per 1,000 workers, the highest rate in the "medical" category.[17] In a Washington State psychiatric facility, 73 percent of staff members surveyed had reported at least a minor injury related to an assault by a patient during the past year; only 43 percent of those reporting moderate, severe, or disabling injuries related to such assaults had filed for workers' compensation. The survey found an assault incidence rate of 437 per 100 employees per year, whereas the reported incidence rate for the hospital was only 35 per 100.[18]

Emergency department personnel face a significant risk of injuries from assaults by patients or their families. Weapon-carrying in emergency departments creates the opportunity for severe or fatal injuries. California and Washington State have enacted standards requiring safeguards for emergency department workers. Because no department in a health care setting is immune from workplace violence, all departments should have violence prevention programs.

Environmental and organizational factors have been associated with patient assaults; including understaffing (especially during times of increased activity such as meal times), poor workplace security,

unrestricted movement by the public around the facility, and transporting patients. A study found that the presence of security personnel reduces the rate of assault; the rate of assault is increased when administrators consider assault to be part of the job, there is a high patient-to-personnel ratio, and work is primarily with mental health patients, or with patients who have long hospital stays.[18a]

Many psychiatric settings now require that all care providers receive annual training in the management of aggressive patients, but few studies have examined the effectiveness of such training. Those that have done so have generally found improvement in nurses' knowledge, confidence, and safety after taking an aggressive behavior management program.

The health care workplace must be made safe for all workers through the use of currently available engineering and administrative controls, such as security alarm systems, adequate staffing, and training.

Needlestick Injuries

The most prevalent, least reported, and largely preventable serious risk health care workers face comes from the continuing use of inherently dangerous conventional needles and sharps devices that lack an engineered injury protection feature. Such unsafe needles transmit blood-borne infections to health care workers employed in a wide variety of occupations. Elimination of unnecessary sharps and the use of sharps devices with engineered injury protection features can dramatically reduce injuries. (See Chapter 15.)

Percutaneous injuries continue to occur in unacceptably high numbers in health care despite the promulgation of the OSHA Bloodborne Pathogen (BBP) Standard of 1991. The physical and mental health consequences of transmission of a potentially fatal blood-borne infection have also remained unacceptable over this period. The requirement under the BBP Standard that hepatitis B vaccine be made available free of charge to health care workers has greatly reduced the consequences of exposure to this pathogen. The advances in the treatment of HIV infection with postexposure prophylaxis has improved the prognosis for those health care workers infected with HIV-contaminated blood. Tragically, there is no vaccine or treatment for hepatitis C virus (HCV), and, therefore, health care workers continue to suffer life-threatening illness after exposure to HCV-contaminated blood. As such, all health care workers, not only those working in the acute care setting or those who traditionally handle needles on a regular basis, should receive every available protection from occupational exposure to blood and body fluids.

After a needlestick injury, the risk of developing occupationally acquired hepatitis B virus (HBV) infection for the nonimmune health care worker ranges from 2 to 40 percent, depending on the hepatitis B antigen status of the source patient. The risk of transmission from a positive source for HCV is between 3 and 10 percent,[19] and the average risk of transmission of HIV is 0.3 percent.[20] However, the risk of transmission increases if the injury is caused by a device visibly contaminated with blood, if the device is used to puncture the vascular system, or if the stick causes a deep injury. All of these diseases are associated with significant morbidity and mortality, and only hepatitis B can be prevented by vaccine. Health care, laundry, and housekeeping workers are all too often engaged in duties that create an environment for these high-risk needlestick injuries.

An estimated 600,000 to 800,000 needlestick injuries occur annually, about half of which go unreported. It is estimated that each year more than 1,000 health care workers will contract a serious infection, such as with HBV, HCV, or HIV from one of these needlestick injuries. Most will become infected due to the growing spread of HCV, which infects 560 to 1,120 health care workers in the United States each year, with 85 percent becoming chronic carriers. At an average hospital, workers incur approximately 30 needlestick injuries per 100 beds per year. Fifty-four percent of reported needlestick and sharp-object injuries involve nurses.[21]

National case surveillance data for 20 years of the HIV epidemic in the United States include 57 health care workers with documented occupationally acquired HIV infection. Eighty-eight percent of health care workers' infections have resulted from percutaneous injuries—41 percent occurring after the procedure, 35 percent during a procedure, and 20 percent during disposal. Unexpected circumstances occurring during or after the procedure accounted for 20 percent of injuries. The national case surveillance system grossly underestimates the number of actual occupationally acquired HIV infections due to reporting difficulties.

There are numerous narrative accounts in the literature concerning the tremendous emotional impact to health care workers after a needlestick event.

The drug treatment regimen is extremely exhausting and debilitating. The emotional threat of having incurred what might be a fatal injury has a profound impact on the daily life of health care workers and their ability to perform their jobs, maintain stable relationships with their co-workers and family members, and have emotional balance. These emotional reactions may be manifest as symptoms of anxiety or even post-traumatic stress disorder.

Use of conventional sharps in the health care environment today has been compared with the use of unguarded machinery decades ago in the industrial workplace. Safer sharps devices have integrated safety features built into the product that prevent needlestick injuries. The term *safer needle device* is broad and includes many different devices, from those that have a protective shield over the needle to those that do not use needles at all. Needles with integrated safety features are categorized as more passive or more active. Passive devices offer the greatest protection because the safety feature is automatically engaged after use, without the need for health care workers to take any additional steps. An example of a passive device is a spring-loaded retractable syringe or self-blunting blood collection device. An example of an active safety mechanism is a sheathing needle that requires the worker to manually engage the safety sheath, frequently using the other hand and potentially resulting in more injuries.

The passage of the federal Needlestick Safety and Prevention Act in 2000 has afforded health care workers better protection from this unnecessary and potentially fatal hazard. Not only does the act amend the 1991 BBP Standard to require that safer needles be made available, but it requires employers to solicit the input of frontline health care workers when making safe needle purchasing decisions. Although there has been widespread conversion to safety in some device categories (such as phlebotomy needles and intravenous catheters), in others (such as laboratory equipment and surgical instruments), relatively few safety devices are in use. A comparison of 1993 and 2001 percutaneous injury rates for nurses documented a 51 percent reduction in needlestick injuries, supporting the use of new technology in reducing percutaneous injury risk.[22]

Latex Allergy

Despite the success of the BBP Standard and related guidance from the Centers for Disease Control and Prevention (CDC) and professional associations, a very significant health problem has emerged that can be attributed, in part, to the increased use of examination and surgical gloves required by the standard. The prevalence of latex allergy among health care workers is estimated to be between 5 and 18 percent, with atopic workers at even greater risk. Individuals with latex allergy are also more likely to develop sensitivity to other allergens, particularly food.

Three types of reactions can occur in persons using latex products: irritant contact dermatitis, allergic contact dermatitis (delayed hypersensitivity), and latex allergy. The most common reaction to latex products is *irritant contact dermatitis*—the development of dry, itchy, irritated areas on the skin, usually the hands. This reaction is caused by skin irritation from using gloves and possibly by exposure to other workplace products and chemicals. Irritant contact dermatitis is not a true allergy. *Allergic contact dermatitis (delayed hypersensitivity dermatitis)* results from exposure to chemicals added to latex during harvesting, processing, or manufacturing. These chemicals can cause skin reactions similar to those caused by poison ivy.

Latex allergy (immediate hypersensitivity) can be a more serious reaction to latex than irritant contact dermatitis or allergic contact dermatitis. Certain proteins in latex may cause sensitization. Although the amount of exposure needed to cause sensitization or symptoms is not known, exposures at even very low levels can trigger allergic reactions in some sensitized individuals. Mild reactions to latex involve skin redness, hives, or itching. More severe reactions may involve respiratory problems, such as runny nose, sneezing, itchy eyes, scratchy throat, and asthma, and anaphylaxis.

In 1997, NIOSH recommended the use of latex gloves only when protection from infectious agents is needed. Most importantly, NIOSH recommended that when latex gloves are used as protection when handling infectious materials, the use of powderless, low-protein latex gloves should be used for protection from blood-borne pathogens in health care and other settings. Substituting nonlatex or powder-free natural rubber latex for powdered gloves has been found to be an effective prevention strategy that reduces the incidence of suspected latex allergy and specifically latex-related occupational asthma. Hospitals with programs or policies to reduce employee exposure to latex reported a 40 percent decrease in latex-related symptoms, with those hospitals with programs in place for greater

than 2 years having a greater decrease in symptoms than hospitals with recently implemented programs.

Chemical Hazards

Health care workers are exposed to a wide range of chemical disinfectants, anesthetic waste gases, and hazardous drugs (such as chemotherapetic medications) that are known to cause adverse health effects and others for which there has been inadequate testing or none at all. NIOSH estimates that the average hospital contains 300 chemicals—twice the number of the average manufacturing facility. Among disinfectants, formaldehyde is a probable human carcinogen and has been linked to occupational asthma in hospitals. Glutaraldehyde (Cidex), a widely used cold-sterilization solution for disinfecting and cleaning heat-sensitive instruments, such as endoscopes, and for fixing tissues in histology and pathology labs, is a respiratory irritant and sensitizer. Ethylene oxide (EtO), a gas sterilant, is a neurotoxin, carcinogen, and reproductive health hazard. EtO has also been associated with lens opacities among workers responsible for changing EtO cylinders. Thousands of health care workers were exposed to harmful levels of this gas before the 1984 OSHA standard for ethylene oxide was issued. It continues to be of concern to central supply hospital workers because of leaks from distribution lines, especially when gas cylinders are being changed. Of particular concern is the fact that the odor threshold for EtO (260 ppm) is well above the OSHA permissible exposure limit (PEL, 1.0 ppm) and the NIOSH recommended exposure limit (REL, 0.1 ppm) and approaches the immediately dangerous to life and health (IDLH) concentration level. In addition, it is highly flammable and therefore poses a dangerous fire and explosion risk.

Anesthetic agents, used in large amounts in hospitals, pose a threat to health care workers when operating room scavenging systems are poorly maintained. Health care workers are also exposed when patients are transferred to the recovery room and exhale anesthesia gases. Specially designed nonrecirculating general ventilation systems with adequate room-air exchanges are necessary in these areas.

Therapeutic agents associated with adverse health effects among workers who handle and administer them include hazardous drugs, such as antineoplastic agents, which are known to cause reproductive effects, cancer, and other adverse effects. Safe handling guidelines were first published in the mid-1980s by the National Institutes of Health, and later by OSHA, to control dermal and inhalation exposures associated with the mixing and administration of these drugs. The guidelines state that these drugs should be prepared in a centralized area by trained individuals under a Class II (B) or III Biological Safety Cabinet. Use of proper glove material that is labeled for use with hazardous drugs is critical, because most of these substances easily penetrate regular latex gloves. Aerosolized medications pose unique threats because of how these drugs are administered. One aerosolized drug, ribavirin, is of particular concern as it is a potential human teratogen. Use of aerosolized medication requires the use of engineering controls, such as specially designed booths and worker respiratory protection, including compliance with all elements of OSHA's respiratory protection standard.

Organization of Work

Organization of work refers to management and supervisory practices as well as production processes and their influence on the way work is performed. Perhaps no other single factor influences worker injury and illness rates more than the manner in which work is organized and staffing decisions are made (Fig. 32-6). Few industries in the United States have undergone more sweeping changes over the past decade than the health care industry. Macro-level changes in the organization of the work of health care delivery have included organizational mergers, downsizing, changes in employment arrangements (such as contract work), job restructuring and redesign, and changes in worker–management relations. Many of these changes have accompanied the emergence of managed care, the priority given to cost containment, and conversions from nonprofit to for-profit health care institutions.

The widespread concern regarding inadequate nursing staffing levels in health care facilities and its impact on health care errors led to a 2003 Institute of Medicine study, which concluded that the work environment of nurses needs to be substantially transformed to better protect patients from health care errors. The report recommended changes in how nurse staffing levels are established, mandatory limits on nurses' work hours, involvement of nurse leaders in all levels of management, and nursing staff input on decisions about work design and implementation. An earlier IOM report (*To Err is*

FIGURE 32-6 • A nurse working in the neonatal intensive care unit carries one infant while attending to another. Inadequate staffing can increase nurses' occupational stress. (Photograph by Earl Dotter.)

Human, 1999) concluded that most medical errors result from basic flaws in the way the health system is organized and recommended that health care organizations create environments in which safety is a top priority and a feature of job design and work conditions.

Despite the increased focus on patient care and nurse staffing, few studies have examined the relationship between organization of work and worker injury and illness. A Minnesota Nurses Association study examined OSHA-200 worker injury and illness logs at 86 Minnesota hospitals over a 4-year period; it found that when nursing staff was reduced by 9 percent, a 65 increase in reported injuries and illnesses occurred. Needlestick and back injuries contributed most to the increase in reported injuries and illnesses.[23]

LEGISLATIVE AND REGULATORY ACTIONS TO PROTECT HEALTH CARE WORKERS

Legislation, regulations, and voluntary guidelines to protect health care workers have been slow in coming and inadequate in their coverage. In 1958, the American Medical Association and American Hospital Association issued a joint statement in support of worker health programs in hospitals. In 1977, NIOSH published criteria for effective hospital occupational health programs. In 1982, CDC published the *Guideline for Infection Control in Hospital Personnel*, which focused on infections transmitted between patient care personnel and patients, not exclusively on health care workers' risks of contracting infectious diseases. CDC guidelines for Blood and Body Fluid Precautions (1982) and Universal Precautions (1987) were published to provide guidance to health care workers. In 1984, OSHA promulgated its first health care worker–specific standard, covering the use of EtO, which was followed by the BBP standard in 1991 and its revision in 2000. OSHA standards addressing tuberculosis and ergonomics were completed but reversed. In 2004, Connecticut became the 10th state to enact nurse-staffing legislation to both protect patients and workers. Despite claims that the nursing shortage has prevented employers from finding nurses, the California nursing-staffing law has had the opposite impact. The wait time for nurses in California to obtain or renew a license increased from weeks to months—evidence that nurses are reentering the field of nursing in response to a more human and patient-friendly environment. Despite progress in efforts to decrease exposure to blood-borne infections, it is unlikely that the higher rates of occupational injuries and illnesses among health care workers will be reversed in the absence of adoption and strong enforcement of new federal regulations covering the leading unaddressed hazards facing health care workers.

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This Web site offers information on cutting-edge issues of primary concern to U.S. nurses. It contains ANA informational brochures on such topics as latex allergy, workplace violence, and pollution prevention in health care. It provides links to relevant Web sites.

Center to Protect Workers' Rights (CPWR). The construction chart book: The U.S. construction industry and its workers. 3rd ed. Silver Spring, MD: CPWR. Available at <http://www.cpwr.com/pulications/page%2049.pdf>.
An excellent compendium of statistics related to the safety and health of construction workers.

International Health Care Worker Safety Center, Charlottesville, Virginia. Available at <www.healthsystem.virginia.edu/internet/epinet>.
The center's Web site contains up-to-date information from their national needlestick injury surveillance program.

National Institute for Occupational Safety and Health (NIOSH) Web site. Available at <http://www.cdc.gov/niosh/homepage.html>.
The NIOSH Web site has special sections for health care, agricultural, and construction workers. Especially useful documents on health care include: Violence: Occupational Hazard in Hospitals at <www.cdc.gov/niosh/2002-101-html>; Latex Allergy: A Prevention Guide at <www.cdc/niosh/93-113.html>; <www.cdc/niosh/02-116 pd.html>. For agricultural workers and construction workers, there are electronic databases of available materials, which are periodically updated: The National Agricultural Safety Database at <www.cdc.gov/niosh/nasd.html> and the Electronic Library of Construction Safety and Health at <www.cdc.gov/niosh/elcosh.html>.

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This document provides a succinct discussion of the background of the problem and a detailed description of the critical elements of a violence prevention program. The documents provide excellent examples of how to respond to these performance-based guidelines, including a staff assault survey, checklists, and forms.

The findings and conclusions in this chapter are those of the authors and do not necessarily represent the views of the National Institute for Occupational Safety and Health.

FIFTH EDITION

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