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Occupational and Environmental Health Surveillance

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How and where are workers injured or made ill on the job?

How many workers are at risk of serious work-related health problems, and where do they work?

How are environmental hazards changing over time and space, and how might they be contributing to disease?

Public health surveillance, in response to these and many other questions, provides answers that ultimately lead to prevention. Surveillance is “the ongoing systematic collection, analysis, and interpretation of health data essential to the planning, implementation, and evaluation of public health practices, closely integrated with the timely dissemination of these data to those who need to know. The final link in the surveillance chain is the application of these data to prevention and control.”¹

The objectives of occupational and environmental health surveillance are the following:

- To characterize the most common types of injuries and illnesses related to occupational and environmental factors, their causes, and their risk factors
- To characterize affected populations

- To estimate the overall magnitude and severity of problems
- To identify geographic areas, industries and occupations, and specific workplaces and communities where interventions are most needed
- To identify new or previously unidentified risk factors that should be researched
- To characterize the distribution of occupational and environmental health hazards
- To evaluate the effectiveness of interventions
- To generate support for prevention activities

Surveillance is often referred to as the “cornerstone of public health practice,” providing the foundation on which to build successful prevention programs. Broadly speaking, surveillance can be divided into surveillance for health outcomes (such as injuries, illnesses, and deaths) and surveillance for hazards or exposures. Ideally, surveillance is ongoing and continuous. Surveys that are performed repeatedly to monitor trends and changes in prevalence are generally regarded as surveillance, but cross-sectional studies and one-time surveys and data collections are generally not—although such activities are sometimes used to augment surveillance data.



The three phases of surveillance. (Drawing by Nick Thorkelson.)

Surveillance for environmental and occupational injuries and illnesses as well as health problems linked to the wide range of types of exposure in these different settings must utilize a wide range of approaches and data sources. Each method and data source will have its own advantages and disadvantages.

Surveillance for diseases caused by environmental exposures is especially challenging because the diseases of interest may have many potential causes. Therefore, the focus is often on hazards in the environment, rather than health outcomes. Surveillance for markers of exposure

to hazards, such as blood lead levels, may also be performed. This chapter focuses on surveillance in the occupational context. An overview and select examples of environmental health surveillance are provided near the end of this chapter.

CASE-BASED AND POPULATION-BASED SURVEILLANCE

Surveillance systems may provide detailed information on cases of injury or illness, generate incidence rates, or both. *Case-based surveillance* involves the ongoing and rapid identification of cases for purpose of follow-up investigation of—and possible intervention for—affected individuals. Case-based surveillance, which is generally used in conducting surveillance of communicable diseases, is based on the concept of a sentinel health event—a warning sign that prevention has failed and intervention is warranted. Follow-up may include interventions—such as to control spread of infectious disease in a community or reduce injury risks among co-workers—and collection of additional data to better understand the epidemiology of the disorder. Data from case-based surveillance may or may not be complete or representative.

Several states implement case-based surveillance for selected occupational disorders using a model developed by the National Institute for Occupational Safety and Health (NIOSH)—the Sentinel Event Notification System for Occupational Risks (SENSOR). Following the SENSOR approach, a state health agency identifies sentinel cases based on reports from health care providers and facilities and uses stringent case criteria to confirm cases. It sometimes obtains additional data from affected workers, health care providers, and employers. State health agencies also use administrative data, such as hospital discharge or workers' compensation records, to identify cases of illness and injury. Results of data analyses are used for prevention and intervention activities. Sometimes, data from several states are aggregated to gain a broader perspective. An example of a case-based surveillance system is the SENSOR asthma program, which uses case reports of work-related asthma from health care providers and other sources to target workplaces for follow-up

investigations and implement broader intervention activities (Box 3-1).²

In contrast, *population-based, or rate-based, surveillance* collects data that can be used to monitor trends in a population over time, locale, and population characteristics. It may involve collecting data on all cases—a census—or on a representative sample of cases. Population-based surveillance requires denominator information—such as the number of workers at risk for a specific injury or illness. The Childhood Lead Poisoning Prevention Programs and the Bureau of Labor Statistics (BLS) Survey of Occupational Injuries and Illnesses (SOII) are examples of population-based surveillance systems.

Case-based and population-based approaches to surveillance are not mutually exclusive; some of the best surveillance systems have attributes of both, identifying sentinel cases for follow-up and simultaneously generating representative summary data to guide broader-based prevention. To influence public health policy, a combination of case reports (stories) and summary data (statistics) is often most effective.

Box 3-1. Asthma Surveillance in California: Combining Environmental and Occupational Health Surveillance

Jennifer Flattery

Some conditions, such as asthma and disorders due to pesticides and lead, occur both in the community and in the workplace and offer opportunities to combine aspects of environmental and occupational surveillance to maximize yield of information and potential for prevention. The California Department of Public Health operates two parallel and complementary programs for asthma prevention, which include surveillance systems for environmental and occupational asthma. The programs collaborate to generate a statewide summary on asthma, profiles on the asthma burden and risk factors for each county in the state, and a statewide blueprint for asthma prevention.

An analysis of work-related asthma data indicated that cleaning chemicals in schools were associated with work-related asthma. Because schools were also a focus of the environmental asthma program for prevention of childhood asthma, a collaborative intervention project was initiated to promote "asthma-safe" cleaning methods in schools through training and technical assistance.

ACTIVE AND PASSIVE SURVEILLANCE

Surveillance systems can generally be characterized as active or passive. Passive surveillance relies on reports to a public health agency of injury or illness submitted by reporting individuals or facilities. Once reports are received, the agency will act on the information received. For example, an adult lead poisoning surveillance program receives reports of elevated blood lead levels (BLLs) from clinical laboratories, then analyzes and disseminates the data, and works with its community partners to develop interventions.

In contrast, active surveillance involves a more aggressive approach to case finding. For example, the Census of Fatal Occupational Injuries (CFOI) devotes much effort to educating potential reporters of work-related fatalities, such as medical examiners, and even uses newspaper searches to identify fatalities. Active surveillance, which is more costly and labor intensive, may be necessary when a passive approach is ineffective.

A surveillance system can incorporate aspects of both active and passive surveillance. For example, the SENSOR surveillance system for occupational asthma partially relies on physicians and nurses to report cases to state public health agencies. Since physicians and nurses may be unaware of reporting requirements or may find them burdensome, outreach and education are necessary to encourage them to report cases. Most surveillance systems require some degree of ongoing feedback and communication with those reporting cases to ensure continued success of the system.

HAZARD SURVEILLANCE

Surveillance for health hazards can be particularly valuable when disease latency periods are long. In such cases, identifying the communities, occupations, workplaces, and/or demographic groups exposed to a hazard can lead to primary prevention, even without data on affected persons. For example, surveillance for asbestos use can lead to mitigation of exposure, thereby preventing development of asbestosis. In contrast, surveillance for mesothelioma, a long-term

outcome of asbestos exposure, identifies cases that may not lead directly to prevention. Many workplaces, work tasks, and even industries that created asbestos exposures that caused current mesothelioma cases no longer exist.

Although there is no U.S. occupational hazard or exposure surveillance system, NIOSH has performed large-scale occupational exposure surveys. From 1981 to 1983 and again a decade later, NIOSH performed the National Occupational Exposure Survey (NOES) to collect data on potential occupational exposures to chemical, physical, and biological agents. The survey involved on-site visits to more than 4,000 workplaces in over 500 industries, with 1.8 million workers in almost 400 occupational categories. From survey data, NIOSH estimated the number of U.S. workers potentially exposed to thousands of hazardous substances, by occupation and industry.

The Occupational Health and Safety Administration (OSHA) also maintains data that can be used to identify possible hazards in a particular workplace. OSHA's Integrated Management Information System (IMIS) database includes information about hazardous exposures measured during OSHA's routine workplace inspections and its complaint- and incident-driven inspections.

Principles of hazard surveillance³ have also been applied to monitoring occupational exposures in order to target opportunities for intervention and to track success in reducing or eliminating exposures. For example, OSHA has established a standard to eliminate exposure to ethylene oxide in hospitals to prevent risks to pregnant workers. Analysis of surveillance data has pointed to successes in reducing exposure and has identified workplaces where more efforts are needed to protect workers.

NATIONAL SURVEILLANCE SYSTEMS FOR OCCUPATIONAL INJURIES AND ILLNESSES

The primary national occupational health surveillance systems in the United States are CFOI and SOII, both of which are administered by the BLS, working in collaboration with the states.

CFOI is designed to count and describe all fatal work-related injuries in the United States (Fig. 3-1).⁴ It gathers data from as many as 25 different sources, such as death certificates and newspaper clippings. CFOI collects information on the worker, and the types of work, industry,

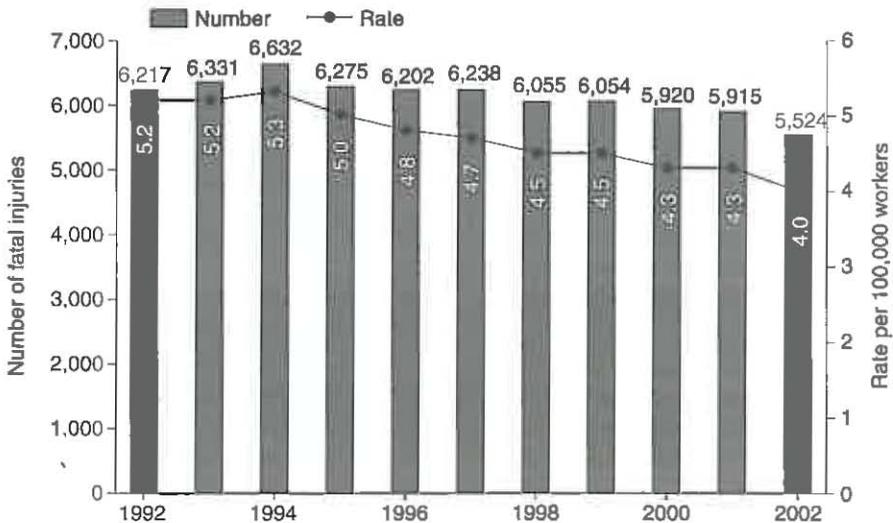


Figure 3-1. Numbers and rates of fatal occupational injuries, United States, 1992–2002. This graph depicts a decline in annual occupational fatality rates from 5.2 to 4.0 per 100,000 workers. (Source: Biddle EA. Is the fatal occupational injury experience in the United States really improving? Number and rate of fatal occupational injuries by year, 1992–2002. Washington, DC: Census of Fatal Occupational Injuries, Bureau of Labor Statistics, 2003. Available at: <http://www.bls.gov/iif/oshwc/cfoi/biddle.pdf>. Accessed on June 16, 2010.)

and workplace. It also collects information on the exposure that led to the injury, the source of injury, activity, and location of the worker at the time of the incident. The BLS provides training and resources for data collection by state agencies, usually state labor or health departments. State agencies transmit data to the BLS, which compiles a national CFOI data set. Each state agency seeks to collect case reports from sources that are specific to the state, facilitating local use of data for intervention.

SOII is the most comprehensive source of nonfatal occupational injury data for the United States, providing estimates of numbers and rates of occupational injuries nationally and for about 40 states, by a range of detailed worker and workplace characteristics. Unlike other major public health surveillance systems, SOII collects data from workplaces, rather than individuals or health care providers or facilities. This allows the BLS to collect information on the source of the injury, the event that caused the injury, and other detailed information about the workplace. Employers, unions, and others can use these data to compare their injury rates to industry averages. SOII relies on a nationwide sample of employers to report data from their OSHA-required records (OSHA-300 logs); farms with fewer than 11 employees, private households, federal government agencies, and self-employed workers are not included.⁴

Injuries and illnesses that are not recorded by employers on OSHA logs or not reported by workers to their employers are missed by SOII. For example, immigrant workers, who often perform the most hazardous tasks, may be reluctant to report their injuries due to possible fear of reprisal or job loss.⁵ In addition, SOII is not a good system for tracking occupational illness, especially chronic diseases. Under-diagnosis of occupational illness by physicians, the long latency periods for some occupational diseases, and the multifactorial nature of many diseases contribute to difficulties in accomplishing surveillance for occupational disease through a workplace-based system such as SOII. Therefore, targeted surveillance systems combining data from select states have been developed for several specific occupational diseases, including adult lead poisoning, occupational pesticide

poisoning, work-related asthma, mesothelioma, pneumoconiosis, and silicosis.

STATE-BASED OCCUPATIONAL HEALTH SURVEILLANCE

State health and labor departments carry out a variety of occupational health surveillance activities, much of which is funded by NIOSH. This surveillance can provide data on local variations in occupational injuries and illnesses, respond to state-specific needs, and facilitate local intervention activities. State-based surveillance can also fill information gaps at the national level by providing data poorly captured by national systems, such as information on occupational diseases. States rely on both existing data, such as data sets of hospital discharges, and data collected specifically for surveillance, such as case reports of occupational illness from physicians and medical care facilities.

As of 2009, NIOSH funded 15 states to implement occupational health surveillance programs. At a minimum, each of these states is encouraged to use data from existing systems to prepare 13 occupational safety and health indicators (Table 3-1).⁶ Activities in these states include surveillance for occupational fatalities, pesticide poisoning, occupational asthma, silicosis, sharps injuries to health care workers, work-related burns, and serious work-related injuries to teenagers and trucking industry workers. Not all states track all outcomes. Additional states are funded by NIOSH to track adult lead poisoning through the Adult Blood Lead Epidemiology and Surveillance (ABLES) program.

Physician and Laboratory Reporting

Public health reporting laws have enabled state agencies to gather surveillance data, mainly on communicable diseases. In 1874, physician reporting of disease to public health agencies began when Massachusetts established a voluntary reporting program in which physicians mailed a postcard every week to the state health department listing "prevalent" diseases. In 1893, Michigan became the first state to require physician reporting of specific diseases. By 1901, reporting of smallpox, tuberculosis, and cholera

Table 3-1. Occupational Health Indicators

Indicator	Source of Data for Indicator
Nonfatal injuries and illnesses reported by employers	Bureau of Labor Statistics (BLS) Annual Survey of Occupational Injuries and Illnesses (SOII)
Work-related hospitalizations	State hospital discharge data
Fatal work-related injuries	Census of Fatal Occupational Injuries (CFOI)
Amputations reported by employers	SOII
Amputations identified in state workers' compensation systems	State workers' compensation data
Hospitalizations for work-related burns	State hospital discharge data
Musculoskeletal disorders reported by employers	SOII
Carpal tunnel syndrome cases identified in state workers' compensation system	State workers' compensation systems
Pneumoconiosis hospitalizations	State hospital discharge data
Pneumoconiosis mortality	State vital records
Acute work-related pesticide poisonings reported to poison control centers	American Association of Poison Control Centers
Incidence of malignant mesothelioma	State cancer registries
Elevated blood lead levels among adults	Adult Blood Lead Epidemiology Surveillance (ABLES) program
Workers employed in industries with high risk for occupational morbidity	Census Bureau County Business Patterns
Workers employed in occupations with high risk for occupational morbidity	Bureau of Labor Statistics Current Population Survey (CPS)
Workers in occupations and industries with high risk for occupational mortality	CPS
Occupational health and safety professionals	Current membership rosters of cited organizations.
Occupational Safety and Health Administration (OSHA) enforcement activities	OSHA Office of Statistics
Amount of workers' compensation awards paid	National Academy of Social Insurance

was legally required in all states. While communicable diseases still dominate the list of reportable conditions, 30 states also require health care providers to report selected occupational disorders, such as work-related asthma, to a state agency. (See Box 3-2.)

While not all cases are reported, these laws have been valuable in facilitating identification of cases of and risks for specific occupational diseases. For example, they have helped to identify health care workers as a group at risk of developing asthma from exposure to chemicals in cleaning products.

Mandatory reporting from laboratories provides the foundation for yet other surveillance programs, such as adult and child blood lead surveillance. As of 2009, there were 40 states participating in the ABLES program (Box 3-3). To participate in ABLES, a state must require clinical laboratories to report BLLs to a state public

Box 3-2. Occupational Health Reporting Requirements in New Jersey

In New Jersey, physicians, advanced practice nurses, and physician assistants are required, by law, to report the following diseases, injuries, and poisonings to the New Jersey Department of Health and Senior Services:

- Asbestosis, silicosis, and other pneumoconiosis
- Work-related asthma
- Extrinsic allergic alveolitis
- Lead, arsenic, mercury, and cadmium toxicity in adults
- Pesticide toxicity
- Work-related injuries in children under age 18
- Work-related fatal injuries
- Occupational dermatitis
- Work-related carpal tunnel syndrome
- Poisoning caused by known or suspected occupational exposure

Health care providers are also asked to report any other occupational disease that is "a threat to worker health."

Source: New Jersey Administrative Code 8:58-1.5, 1.6, and 1.7. Available at: <http://www.nj.gov/health/ohs/rptrequirement.shtml>. Accessed on October 6, 2009.

Box 3-3. Tracking Lead Exposure to Workers:
The Massachusetts Blood Lead Registry

Richard Rabin

In 1990, the Massachusetts Legislature passed the Occupational Lead Poisoning Registry Law, which requires laboratories in the state to report blood lead levels (BLLs) of 15 $\mu\text{g}/\text{dl}$ or higher in adults to the Massachusetts Occupational Lead Poisoning Registry in the Division of Occupational Safety (DOS). The Registry, which participates in ABLES, informs workers about the hazards of lead and how exposures can be controlled, provides employers with information and technical assistance to control lead exposure, and provides consultation and advice to health care providers on medical management of lead poisoning.

The Massachusetts Department of Public Health periodically analyzes Registry data and distributes reports to physicians, employers, unions, legislators, and other interested parties. These reports help to identify industries, occupations, and workplaces that present the greatest lead hazards and to target them for follow-up investigation and intervention. Data collection also permits the study of trends in the incidence of lead poisoning over time.

Upon receiving a report of an elevated BLL, the Registry contacts the physician who ordered the test to obtain further identifying information about the reported worker and lead exposure, and to provide medical guidelines to the physician. Its medical consultant is available to consult on individual cases. The Registry then calls the worker to gather more information on lead exposure and workplace conditions, and it sends the worker information on occupational lead exposure and workplace rights. When the employer is identified, the Division of Occupational Safety refers the case to the Occupational Safety and Health Administration (OSHA) and/or contacts the employer to discuss the problem and offer a worksite consultation.

Between 1999 and 2002, the Registry received reports of elevated BLLs—64, 63, and 48 $\mu\text{g}/\text{dl}$ —in three immigrant Brazilian house painters who were not fluent in English and worked for the same painting company. According to the workers and their physicians, the employer had not complied with the OSHA lead standard. There had been no medical monitoring and no training or information provided on the health hazards of lead. The Division of Occupational Safety provided consultation to this company and continues to monitor its progress in protecting its employees from lead exposure.

health agency. State and local public health agencies rely on both physician and laboratory reporting to obtain information on children with elevated BLLs. As of 2009, 46 states reported data to the CDC Childhood Blood Lead Surveillance System.

**THE USE OF ADMINISTRATIVE DATA
FOR OCCUPATIONAL HEALTH
SURVEILLANCE**

Data collected for administrative purposes, such as workers' compensation, hospital discharge, and emergency department data, can contain information on injuries and illnesses not reported into employer-based surveillance systems.

Workers' Compensation Data

Workers' compensation data have been used extensively for research and surveillance. For example, the Massachusetts Teens at Work (TAW) program identifies an average of 400 cases annually of serious work-related injuries to teenagers by using workers' compensation data. TAW estimates rates of work-related injuries to teenagers and performs demographic and occupational analyses of data on injured teens.⁷ TAW uses these analyses to plan interventions and also shares findings with community organizations, schools, employers, unions, and policy makers. Washington State's Safety and Health Assessment and Research for Prevention (SHARP) program stands out for its regular reporting on a variety of injuries and illnesses from its state workers' compensation system. Several other state programs access and utilize workers' compensation data as an important source of data on the occupational health of workers in their states.

Workers' compensation data have limitations for use in surveillance. Workers awarded compensation are not representative of all those with work-related injuries and illnesses. Not all worker groups are equally likely to receive benefits. In addition, differences in eligibility for workers' compensation among states make comparisons between states difficult.

**Selected Other Occupational Health
Surveillance Systems**

The National Electronic Injury Surveillance System (NEISS)

The Consumer Project Safety Commission (CPSC) operates NEISS, which is based on a U.S. probability sample of hospital emergency departments (EDs). It collects information from

participating hospitals on ED visits involving nonfatal injuries associated with work or consumer products.

National Agricultural Workers Survey (NAWS)

Initiated in 1988, NAWS is a probability survey of a sample of U.S. hired crop workers, originally designed to collect demographic and employment data. NIOSH has incorporated occupational health questions into this survey to guide interventions among farmworkers.

National Healthcare Safety Network (NHSN)

NHSN is a voluntary, Internet-based surveillance system, managed by the CDC, that integrates and expands surveillance systems for the safety of patients and health care workers. It conducts surveillance for exposures to blood and body fluids and to influenza, and monitors vaccination of health care workers against influenza.

National Occupational Respiratory Mortality System (NORMS)

NORMS is an interactive data system that is based on mortality data provided annually from the National Center for Health Statistics. Information on deaths for which the underlying or contributing cause was pneumoconiosis, malignant mesothelioma, or hypersensitivity pneumonitis is included. NORMS also determines annual industry- and occupation-specific death rates for many respiratory disorders.

Occupational Health Indicators

Health indicators are well-defined surveillance measures that allow states to uniformly collect and report on the health status of the population. States use both occupational and environmental health indicators to track health problems and to guide prevention and intervention measures (Tables 3-1 and 3-2).⁸ Some of these indicators can also be used to compare rates of illnesses and injuries among states.

Healthy People Objectives

The Healthy People objectives for the United States, which are developed for each decade,

Table 3-2. Types and Examples of Environmental Health Indicators

Hazard Indicators (Potential for Exposure to Contaminants or Hazardous Conditions)
Criteria pollutants in ambient air
Hazardous or toxic substances released in ambient air
Residence in nonattainment areas (for criteria air pollutants)
Motor vehicle emissions
Tobacco smoke in homes with children
Residence in a flood plain
Pesticide use and patterns of use
Residual pesticide or toxic contaminants in foods
Ultraviolet light
Chemical spills
Monitored contaminants in ambient and drinking water
Point-source discharges into ambient water
Contaminants in shellfish and sport and commercial fish
Exposure Indicators (Biomarkers of Exposure)
Blood lead level (in children)
Health Effect Indicators
Carbon monoxide poisoning
Deaths attributed to extremes in ambient temperature
Lead poisoning (in children)
Noise-induced hearing loss (nonoccupational)
Pesticide-related poisoning and illness
Illness or condition with suspected or confirmed environmental contribution (a case or an unusual pattern)
Melanoma
Possible child poisoning (resulting in consultation or emergency department visit)
Outbreaks attributed to fish and shellfish
Outbreaks attributed to ambient or drinking water contaminants
Intervention indicators (programs or official policies addressing environmental hazards)
Programs that address motor vehicle emissions
Alternate fuel use in registered motor vehicles
Availability of mass transit
Policies that address indoor air hazards in schools
Laws pertaining to smoke-free indoor air
Indoor air inspections
Emergency preparedness, response, and mitigation training programs, plans, and protocols
Compliance with pesticide application standards (among pesticide workers)
Activity restrictions in ambient water (health-based restrictions)
Implementation of sanitary surveys
Compliance with operation and maintenance standards for drinking water systems
Advisories to boil water

include a set of objectives specific to occupational health and safety and a set of objectives specific to environmental health.⁹ These objectives are developed by staff members of federal and state agencies, academic and community-based

researchers, and others. Baseline surveillance data are necessary for a Healthy People objective to be established.

Healthy People 2020 objectives for occupational health and environmental health outcomes can be accessed at <http://www.healthypeople.gov/hp2020/default.asp>.

Box 3-4. National Childhood Blood Lead Surveillance

Lemuel Turner

Approximately 250,000 U.S. children 1 to 5 years of age have blood lead levels (BLLs) greater than 10 µg/dL, the level at which the Center for Disease Control and Prevention (CDC) recommends public health actions be initiated. Because young children are at highest risk for lead poisoning, the CDC recommends that screening programs focus on children under 6 years of age.

State and community health agencies are principal delivery points for childhood lead screening and case management. These agencies receive laboratory reports of children with elevated BLLs and collect demographic information and data on risk factors for lead poisoning during case investigations of these children. Many states do not have resources to independently develop lead surveillance systems that can systematically collect and maintain computerized records from laboratories on BLLs, and from environmental departments that conduct inspections and report on remediation activities. In 1992, the CDC began awarding cooperative agreements to state and local departments of health or departments of the environment for implementation of childhood blood lead surveillance. The CDC developed and provided to state and local Childhood Lead Poisoning Prevention Programs (CLPPPs) the Systematic Tracking of Elevated Lead Levels and Remediation (STELLAR) program. STELLAR allowed CLPPPs to conduct BLL surveillance, patient medical case management, and environmental investigation management, and to report surveillance data to the CDC. The CDC currently receives surveillance data quarterly from 42 comprehensive CLPPPs. Forty of these programs have been awarded cooperative agreements by the CDC. The surveillance data are a portion of the larger patient tracking system.

In 2000, the President's Task Force on Environmental Health Risks and Safety Risks to Children issued a new federal strategy entitled "Eliminating Childhood Lead Poisoning: A Federal Strategy Targeting Lead Paint," with recommendations to support state-based blood lead surveillance systems and capacity to use data linkage to monitor lead screening in the Medicaid population. This new strategy reinforces the 1991 Department of Health and Human Services "Strategic Plan for the Elimination of Childhood Lead Poisoning." The 1991 plan called for several strategies, including increased federal support for childhood lead poisoning prevention programs and national surveillance. The national and state systems are complementary.

MEDICAL SURVEILLANCE AND MEDICAL SCREENING

Distinct from the population-based surveillance that is the focus of this chapter, *medical surveillance* is the ongoing medical monitoring of exposed individual workers in a company,

The purposes of state surveillance and patient tracking are the following:

- To monitor case management of individual children with lead poisoning
- To evaluate the productivity and effectiveness of state and local programs
- To identify local program needs such as capacity building in inspection and abatement methods and laboratory services
- To identify clusters of cases to target preventive interventions
- To identify possible sources of lead and remove or reduce those exposures

The purposes of national surveillance and patient tracking are the following:

- To track national progress in eliminating childhood lead poisoning
- To track the number of children with lead poisoning to prioritize federal resources
- To evaluate the effectiveness of the CDC grant program
- To assess the effectiveness of state prevention activities to improve interventions
- To monitor national trends in lead sources exposing children

As screening activities become more effective at targeting high-risk children, surveillance data will more accurately represent the burden of childhood lead poisoning in the United States. In addition, information collected from surveillance programs will facilitate a comprehensive assessment of prevention effectiveness of childhood lead poisoning prevention activities. Trends can be tracked over time to assess the impact of childhood lead poisoning prevention activities on elimination of this disease, which will require removal and/or reduction of sources of lead in the environments of children. Documentation of all lead sources identified and actions taken to reduce the exposures will be important to track over time.

In 2008, the CDC began the development of the Healthy Housing and Lead Poisoning Surveillance System (HHLPPSS) to replace STELLAR. HHLPPSS is a Web-based system that vastly improves the ability of state and local CLPPPs to provide real-time services to their residents, greatly enhances the mission to eliminate childhood lead poisoning, and, for the first time, monitors housing risk factors other than lead that are associated with adverse health effects.

workplace, or other specific cohort. Individual companies may perform medical surveillance of their workers. Epidemiologists may conduct medical surveillance of a cohort of workers as part of a study. OSHA requires medical surveillance of workers exposed to some specific hazardous substances and exposures, including acrylonitrile, arsenic, asbestos, benzene, blood-borne pathogens, 1,3-butadiene, cadmium, suspect carcinogens, coke oven emissions, cotton dust, 2-dibromo-3-chloropropane, ethylene oxide, formaldehyde, lead, methylenedianiline, methylene chloride, noise, and vinyl chloride, as well as compressed air environments, hazardous waste, and hazardous chemicals in laboratories.¹⁰ Government actions and legislative mandates also place certain cohorts of workers under medical surveillance. (See Chapter 2.)

An example of a medical surveillance program established by legislative mandate is the Former Worker Medical Surveillance Program of the U.S. Department of Energy (DOE). In 1993, Congress ordered the DOE to conduct medical surveillance for those who had worked with toxic and radioactive substances in U.S. nuclear weapons production. This program has provided medical screening and follow-up to thousands of former workers and has generated

information about health problems in these workers.¹¹ For example, 1.3% of former Nevada Test Site workers who were screened had sensitization to beryllium, evidence of past exposure to this metal whose particles can cause berylliosis, an incurable lung disease.¹² In some individuals, a single exposure to beryllium can result in berylliosis.

ENVIRONMENTAL HEALTH SURVEILLANCE

Environmental health surveillance may include monitoring of environmental hazards, exposures to toxic environmental contaminants, or diseases caused by environmental factors.¹³ Public health workers need to collect data regularly and systematically to determine, in a timely manner, whether levels of environmental contaminants are associated with illness in their communities. Environmental health surveillance typically utilizes a variety of data sources, each with its advantages and disadvantages.¹⁴ National data sources for environmental health surveillance, such as in government agencies, have tended to be fragmented.¹



Figure 3-2. Young children living in inner-city tenement buildings, as shown here, are at high risk for childhood lead poisoning. Surveillance programs can help identify children at high risk and lead to intervention and other preventive measures. (Photograph by Earl Dotter.)

Conducting surveillance on factors that could be used for prevention in the short term may be more valuable than focusing on diseases with long latency.¹⁵ Environmental health surveillance systems in the United States focus on childhood lead exposure (Box 3-4 and Fig. 3-2), spills of hazardous substances and resultant health outcomes, carbon monoxide poisoning (Box 3-5), and combining fragmented sources of data into one readily accessible network. These disparate systems share the common purpose of using collected data and analyses to improve the public's health.

There is great interest from both the public and the public health community in understanding the distribution and risk factors for asthma. However, asthma, unlike many infectious

diseases, is not reported to the Centers for Disease Control and Prevention (CDC). Surveillance for asthma is accomplished primarily through a national telephone survey called the Behavioral Risk Factor Surveillance System (BRFSS). CDC funding and support of the BRFSS have resulted in detailed collection of self-reported data on asthma from all 50 states. The National Environmental Public Health Tracking Network integrates and centralizes data from many sources for use by scientists, health professionals, policy makers, and members of the public (Box 3-6).

Much environmental health surveillance is also conducted at the state (or local) level, although it may be coordinated at the federal level. For example, state and local health departments

Box 3-5. Carbon Monoxide Poisoning Surveillance

Shahed Iqbal, Fuyuen Yip, Jacquelyn H. Clower, and Paul Garbe

Carbon monoxide (CO) is a colorless, odorless gas that is produced from the incomplete combustion of hydrocarbons. Major nonoccupational sources include poorly maintained and poorly ventilated home heating systems and cooking appliances, motor vehicle exhaust, and gasoline-powered or other fuel-powered equipment, such as portable generators and space heaters. Unintentional and non-fire-related carbon monoxide exposure results in nearly 450 deaths, more than 4,000 hospitalizations, and more than 20,000 emergency department visits annually in the United States.¹⁻³

Symptoms of CO exposure range from minor flu-like symptoms, such as fatigue, headache, dizziness, nausea, vomiting, and confusion, to more severe effects, such as disorientation, collapse, coma, cardiac effects, and even death. Many affected people develop neurological sequelae, including impaired memory and executive functioning.

Because of its frequency, severity, and preventability—as well as the effectiveness of simple preventive measures, such as the installation of CO alarms, CO poisoning is a critical issue for public health surveillance.⁴ Data for national surveillance of CO-related mortality and morbidity come from the National Vital Statistics System, the National Electronic Injury Surveillance System All Injury Program, and reports from hyperbaric oxygen treatment facilities. These data sources, however, are not designed primarily for CO poisoning surveillance. Data collected for purposes other than surveillance may suffer from limitations in timeliness, availability, completeness, data quality, and representativeness; therefore, there is need for

a more comprehensive national surveillance system for CO poisoning.

Identification of more appropriate data sources and development of a national CO poisoning surveillance framework is ongoing. In addition to the existing sources, data for CO poisoning surveillance are now being drawn from the Nationwide Inpatient Sample and Nationwide Emergency Department Sample from the Hospitalization Cost and Utilization Project (HCUP). These nationally representative samples are drawn from the largest repository of hospital discharge data in the United States. For surveillance of CO exposures, the National Poison Data System, which is maintained by the American Association of Poison Control Centers, is also being utilized. This is the only national poisoning surveillance database that compiles exposure information from poison centers. Plans are being made to include CO-related health behavior questions, such as generator use and presence of working CO alarms in homes, in national surveys, such as the National Health Interview Survey, the American Housing Survey, and the Behavioral Risk Factor Surveillance System.

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Box 3-6. Environmental Public Health Tracking Network

The Environmental Public Health Tracking Network (EPHT), operated by the Center for Disease Control and Prevention (CDC), is a Web-based system initiated to track and report on environmental hazards and health outcomes that may be related to environmental factors. It presents health, exposure, and hazard information, and data from a variety of national, state, and city sources. It includes information on asthma, cancer, myocardial infarction, reproductive disorders and abnormal birth outcomes, childhood lead poisoning, and carbon monoxide poisoning.

Combining environmental and public health data, EPHT enables scientists, health professionals, policy makers, and members of the public to see where these hazards and health problems are present, to better understand the associations between the environment and its adverse effects on health, to assess unusual trends and events to determine which communities may be at risk, and to improve preventive measures. For example, parents can learn about asthma or air contaminants and take action to protect their children, such as by advocating for reducing the use of chemicals in school buildings. Elected officials can see air-quality trends in their communities to determine whether actions taken to reduce pollution levels are effective. Key features of EPHT are standardized environmental and health data for all contributing states, data organized by location, and easy-to-read maps, charts, and tables. Environmental data from EPHT include air quality related to ozone and particulate matter (PM_{2.5}), community water contaminants, and well water contaminants. The CDC is funding state and city health departments to build local tracking networks. Through states' participation in EPHT, data from many state surveillance activities will ultimately be available at the EPHT Web site.

The Tracking Network continues to grow as the CDC increases the types of data available and adds new capabilities. More information is available at: <http://www.cdc.gov/ephttracking>.

receive laboratory reports of children with elevated BLLs and collect demographic information and data on risk factors for lead poisoning during case investigations of these children. The CDC provides funds to state and local agencies to implement childhood blood lead surveillance. State and local activities focus on identifying individual children for follow-up, pointing out local sources of lead exposure, and identifying targets for intervention based on the occurrence of clusters of cases. In contrast, the role of the CDC includes tracking national

Box 3-7. Surveillance for Childhood Lead Poisoning Reveals Workplace Lead Problem

Workers exposed to lead on the job can transport lead dust home from a worksite through clothing, shoes, tools, or vehicles. In 2008, the Maine Childhood Lead Poisoning Prevention Program (MCLPPP) discovered the first reported cases of lead poisoning caused by elevated lead dust on child safety seats. During that year, MCLPPP identified 55 new cases of elevated venous blood lead levels (BLLs) (15 µg/dL or higher) among children under age 6 through mandated routine screening. (Screening requirements exist for children on Medicaid.) Children with venous BLLs 15 µg/dL and higher trigger an environmental investigation to determine the lead sources, and children are monitored until their venous BLLs are below 10 µg/dL.

Although 90% of childhood lead poisoning cases in Maine during 2003–2007 had been linked to lead hazards in the child's home, no lead-based paint, dust, or water with elevated lead levels were found inside the homes associated with six of the 2008 cases. When no lead dust was found within the children's homes, an expanded environmental investigation was conducted. In two of five homes, lead dust was detected in exterior areas where family members removed and kept work clothes, such as an entryway or laundry room. All family vehicles and all six child safety seats tested positive for lead dust.

The MCLPPP determined that the children were exposed to lead dust in the family vehicles and child safety seats. Among the five families, contacts included four persons who currently or recently worked in painting and paint removal, and one who was a self-employed metals recycler. The workers reported no lead-related occupational safety measures provided by their employers at worksites. A case of take-home lead poisoning was defined as: (a) a confirmed venous BLL 15 µg/dL or higher in a child under age 6 living in Maine; (b) a household contact in a high-risk lead-related occupation; and (c) environmental lead dust sampling of vehicle and child safety seat 40 µg/ft² or higher, with no detectable lead-based paint hazards present in the home.

During 2003–2004, 95% of reported elevated BLLs in adults were related to occupational exposures, especially in painting, the industry subsector which also had the highest number of lead-exposed workers. Both the Occupational Safety and Health Administration (OSHA) general-industry and construction lead standards require employers to provide washing, shower, and clothes-changing facilities for their employees who are exposed to lead above the permissible exposure limit (PEL). However, the parents and household contacts studied in Maine reported a lack of facilities available for washing, showering, and changing clothes before entering their personal vehicles.

Source: Adapted from: Centers for Disease Control and Prevention. Childhood lead poisoning associated with lead dust contamination of family vehicles and child safety seats—Maine. *Mortality and Morbidity Weekly Report* 2008; 58: 890-893.

Box 3-8. Infectious Disease Surveillance and Occupation

In the United States, surveillance systems for infectious disease usually do not include information on the individual's occupation or workplace. Pandemics, such as the novel H1N1 pandemic, point to the opportunity for surveillance systems to identify the workers most at risk for the illness, identify points of transmission to workers and other members of the public, and enable public health officials to quickly help workplaces institute preventive measures. During an influenza epidemic, health care workers are at high risk for illness, and resultant absenteeism can strain the health care delivery system. The inclusion of industry and occupation information in ongoing surveillance is helping to identify other groups of workers who may benefit most from interventions during future pandemics.

progress in eliminating childhood lead poisoning, tracking the magnitude of the problem nationally, and evaluating the effectiveness of both state and local surveillance activities.

Although occupational and environmental health surveillance systems are almost always separate, there can be value in including both occupational and environmental health within a more holistic approach to public health surveillance.¹⁶ Occupational and environmental exposures are linked with common outcomes. Furthermore, many of the same populations, such as low-income, underserved populations, may suffer disproportionately from exposures both in the environment and in the workplace (Box 3-7). Even more broadly, infectious disease surveillance can sometimes benefit from an analysis by occupation, industry, or geography. Information on residence or workplace can lead to the identification of risk factors or clues to controlling the spread of transmission (Box 3-8).

EVALUATION OF SURVEILLANCE SYSTEMS

Surveillance systems should be periodically reviewed to determine whether they are serving an important public health function and whether they are operating well. It is important to consider whether a given injury or illness is important enough to remain under surveillance. An evaluation of a surveillance system includes

evaluating the data collection methods (and their efficiency) and the attributes of the system, including representativeness, sensitivity, and timeliness.¹⁷ Crucial to evaluation is an assessment of the system's usefulness by external stakeholders and partners who are responsible for prevention and intervention activities.

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