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Surveillance, Monitoring, and Screening in Occupational Health

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▸ TYPES AND PURPOSES OF WORKPLACE HEALTH EXAMINATIONS

Health examinations are performed in workplaces for several distinctly different purposes. For example, the most common purpose of the preplacement medical examination, which occurs after an offer of employment has been made but before an individual is placed on a specific job, is to determine if the individual has significant physical or mental impairment that would preclude the individual from performing specific essential duties related to a particular job. While this is one of the principal functions of the preplacement examination, the examination itself may be comprehensive, except in Minnesota due to a state law.[1]

One of the most common purposes of workplace health examinations and one that is most relevant to improving the health of the workforce is to identify toxic health effects at an earlier stage than they would be detected without the examination.[2] This type of screening program is often initiated with a baseline examination and then followed with periodic follow-up examinations. The goal of this type of program is secondary prevention. It may benefit not only the individuals who may have diseases or toxic effects that are detected before they would have sought medical care, but may indirectly benefit other similarly exposed workers since the detection of work-related health effects should trigger an investigation of the workplace. Additionally, if excessive exposures are found, it should lead to efforts to reduce hazardous exposures or change unsafe working conditions. If large groups are tested, the test data can be analyzed to identify group trends. This can lead to the detection of more subtle changes than the evaluation of data solely on a case-by-case basis. This type of screening examination should be voluntary and is intended to benefit the individual worker who is screened. Therefore, the screening tests used in these periodic examinations should be evaluated to ensure that the tests are effective for screening objectives.

A common adjunct to medical monitoring or screening is biological monitoring, which is the measurement of workplace agents or their metabolites in biological specimens, usually blood or urine, for the purpose of monitoring the level of exposure and adsorption. This approach to exposure assessment is particularly useful when adsorption is possible by dermal exposure. Biological monitoring should not be used to replace careful assessment of exposure conditions by other effective methods such as environmental air measurements.

▸ ETHICAL ISSUES IN HEALTH EXAMINATIONS IN THE WORKPLACE

One of the important differences between medical examinations in the occupational setting and those in other settings is that the relationship between the health care provider and the examinee is not, from a legal point of view, the traditional physician-patient relationship. In the traditional physician-patient relationship, the health care provider serves only the interests of the patient and the health care provider's only loyalty is to the patient.[1] When the employer hires or contracts for the occupational health care provider, the provider may have difficulty resolving conflicts of interest between the employer and the employee-patient. This conflict is one of the most important ethical concerns of occupational health.[1] Ethical codes have been developed by both the American College of Occupational and Environmental Medicine (ACOEM) and the International Commission on Occupational Health (ICOH).[3,4] Rothstein has proposed a Bill of Rights of Examinees.[1] ICOH codes explicitly deal with many of the issues related to screening and surveillance activities, and the ACOEM has a position on medical surveillance in the workplace.[5] All of these codes recognize the need to maintain the confidential nature of most medical screening information. This concept is reinforced by the Americans with Disabilities Act (ADA). All medical information must be collected and sorted in separate medical files.[1] Under ADA, management may be informed of workers' restrictions that limit their ability to perform the job duties.[1] In addition to ADA, other federal and state laws or regulations such as the Occupational Safety and Health Act, Department of Transportation examinations for interstate truck drivers, or state laws on human immunodeficiency virus (HIV) or drug testing deal with the issue of medical confidentiality. While the Occupational Safety and Health Administration (OSHA) mandates various preplacement and periodic medical examinations that employers must offer employees, the employees have the right to refuse to participate in these OSHA-mandated examinations unless this is part of the specific employee-employer contract.[6]

One of the best methods to address the ethical issues in workplace examinations and to ensure a high level of voluntary participation in a workplace screening program is to carefully educate workers about the program. Rothstein has suggested a number of issues that should be addressed in any education effort [1] (Table 33-1).

Maintaining the confidentiality of medical data is not only important from the legal and ethical perspective but is critical in facilitating the employee's participation in the program.

TABLE 33-1. CRITICAL INFORMATION ON MEDICAL TESTING PROGRAMS IN THE WORKPLACE[1]

Describe the purpose and nature of the examination.
Explain who is employing the health care provider.
Describe efforts to protect the confidentiality of the collected data.
Describe who will be provided with the results of the examination and how the information will be used, including what actions will be taken to further evaluate possible hazardous workplace exposures.
Describe how the worker will be notified of individual and group test results.
Describe how the worker may have access to his or her health records.
Describe how medical follow-up may be obtained if the test results are positive.

Adapted from Rothstein MA: Legal and ethical aspects of medical screening. Occup Med 11(1):31–39, 1996 and Rempel D: Medical surveillance in the workplace: overview. Occup Med 5(3):435–438, 1990.

▶ SELECTING THE COMPONENTS OF PERIODIC EXAMINATIONS

OSHA standards require periodic examinations for approximately 30 agents. Several common occupational exposures, such as asbestos, benzene, cotton dust, ethylene oxide, formaldehyde, lead, and noise, are covered by these specific OSHA standards. Generally, these examinations are required if a worker is exposed above a specific level of exposure, which is often one-half of the 8-hour permissible exposure limit (PEL).[7] For example, OSHA requires baseline and annual audiometry testing in employees exposed to noise at an average of 85 dBA or above for a typical 40-hour work week. The National Institute of Occupational Safety and Health (NIOSH) recommends periodic testing on a larger list of agents. Table 33-2 illustrates the medical surveillance features of the OSHA Lead Standard 1910.1025.[7]

The first step in deciding whether to institute a program of periodic medical screening is to thoroughly evaluate the occupational exposures of the working population that may be surveyed. In addition to looking to see if there are medical surveillance activities recommended by OSHA or NIOSH, a decision to institute a program can be based on three criteria: the level of exposure; the identification of the most likely types of adverse outcomes; and the availability of a suitable screening test. While there is often substantial scientific uncertainty about the shape of the exposure-effect relationship between many occupational exposures and adverse health outcomes, information about the level of exposure may indicate the probability of identifying a work-related effect is extremely unlikely. In this situation, one may infrequently survey exposed workers to confirm the absence of work-related adverse health effects. In developing a new examination program, one should determine what the adverse health effects are that are most likely to occur with exposure. This is usually based on a review of the animal and human data and the identification of the most sensitive organ system to the specific exposure. The most common adverse health effects are often nonspecific symptoms such as headaches or upper respiratory tract irritation or changes in the respiratory tract that are detectable with simple pulmonary function testing. The components of a medical screening program have been proposed (Table 33-3).[6,7]

The next logical step after the identification of the health effects that should be detected by a screening program is to identify the tests to be included in the program and the frequency of testing of individuals. Most questionnaires and medical tests that are commonly included in occupational screening programs have not been extensively evaluated for their ability to detect those with and those without adverse health effects. An efficient medical screening program should detect most individuals with subclinical adverse health effects (high sensitivity) while not mislabeling any truly healthy individuals (high specificity). When employees are found to have adverse work-related health effects, actions should be undertaken to identify workplace exposures that are hazardous and identify steps to be undertaken to reduce the excessive exposures. These efforts to evaluate exposure should be extended beyond the individual with abnormal test results to other workers with similar exposures. The test must be free of any significant risk for the screened subjects, since the main use of the test is to identify subclinical disease or diseases before an employee would normally seek health care. The test must also be acceptable to the screened population. While medical screening and surveillance are important activities, the most important approach to preventing occupational diseases and injuries is to reduce or eliminate exposure to hazardous agents and unsafe situations in the workplace.

▶ SURVEILLANCE

Definition

The previous discussion is focused on the role of screening and of periodic examinations in occupational health. One of the potential roles of these examinations is to supplement other occupational surveillance. Occupational surveillance is the ongoing and systematic collection, analysis, and interpretation of data related to either occupational exposures (hazard surveillance) or adverse health outcomes (injuries, disorders, or diseases).[8,9] Hazard surveillance should be an important part of occupational surveillance activities. The identification of occupational exposures (hazard surveillance or exposure assessment) before work-related diseases or injuries have developed or occur should trigger further evaluation of the workplace. If high or unsafe levels of exposure are found, then these exposures can be reduced by implementation of either administrative or engineering control activities. The primary goals of surveillance are different from the goals of screening programs. The classic purpose of screening is to identify

TABLE 33-2. OSHA'S MEDICAL SURVEILLANCE PROGRAM FOR LEAD

Initial evaluation: Examination with attention to the teeth, gums, hematologic, gastrointestinal, renal, cardiovascular, and neurological systems; blood pressure; blood sample for blood lead; hemoglobin and hematocrit, red cell indices and peripheral smear morphology, zinc protoporphyrin (ZPP), blood urea nitrogen (BUN), serum creatinine; routine urinalysis (U/A)
Periodic evaluation: Biological monitoring of blood lead and ZPP every 6 months or every 2 months if last blood lead at or above 40 µg/100 g of whole blood; monthly during medical removal; examinations usually for any employee with blood lead at or above 40 µg/100 g during the preceding 12 months
Physician's written statement: To include recommended special protective measures or limitations to be placed upon employee
Special requirements: Allows for multiple physician review of mechanism; provides medical removal protection

TABLE 33-3. COMPONENTS OF A MEDICAL SURVEILLANCE PROGRAM

Exposure assessment and identification of most likely adverse health effects
Selection of medical tests based on evaluation of test characteristics
Identification of employees to be tested and testing frequency
Training of testing staff
Analysis and interpretation of individual and group test results
Actions based on test results
Verification of test results
Notification of employees and the employer while protecting confidentiality
Additional tests or treatment and steps to reduce an individual's exposure
Exposure evaluation and reeducation of hazardous exposures
Maintenance of records
Evaluation for adequate quality control and revise based on the program performance

patients who have asymptomatic disease in order to initiate therapy early in the natural course of the disease.

Goals

The goals of health or injury surveillance are ideally related to prevention activities. The first goal of surveillance is the identification of new or previously unrecognized problems. Identification will occur with the association of an injury or disease with a specific work process or occupation.[10] This generally happens through two types of surveillance data: either the identification of cases without definite information about the size of the population (the cases are drawn from the sentinel health event); or from a surveillance source of cases that include some information both on the number of cases and the size of the population at risk. An example of the first type of surveillance is a recent report of cases of hypersensitivity pneumonitis with exposure to metalworking fluids.[11] An example of the second type of surveillance is the elevated rate of workers' compensation claims for carpal tunnel syndrome in certain industries in the state of Washington.[12] These two examples illustrate that surveillance activities often involve data such as workers' compensation claims that are collected for other purposes and may be conducted at the level of individual worksite or at a state or national level.

The second goal of surveillance is to determine the magnitude of the problem either at the national, state, or local level. This is one of the most important goals of surveillance from the perspective of prevention. Surveillance data can be used to determine where to focus prevention efforts.

At the national level, surveillance data can be used to identify which industries are at high risk. One of the few sources of national data is collected by the Bureau of Labor Statistics (BLS) in the Department of Labor, which surveys a representative sample of private sector employers with more than 11 employees each year.[15] The number of occupational illnesses and injuries is collected from each surveyed employer. This system was recently revised to improve the classification of occupational diseases and to collect more information about the etiology of diseases and injuries.[16]

Data in Table 33-4 illustrates a characteristic of some occupational surveillance systems. Using industry type, occupation, or job title as a surrogate for the intensity or frequency of exposure has important limitations. Sometimes the industry or job title is an adequate title for exposure; however, more frequently there is substantial variation in the intensity or frequency of exposure within an industry or a common job title. For example, meat packing plants have many highly repetitive jobs that are associated with work-related musculoskeletal injuries of the upper limb; in this case, industry type is an adequate surrogate.[13] Some of the differences between the low- and high-risk industries are possibly the result of a lower ratio of high-risk jobs to low-risk jobs in the lower-risk industries. Despite the limitations of this surveillance system, industries or occupations identified as high risk should be further evaluated.

The magnitude of the occupational injury or disease problem can be estimated at the national, state, or facility (local) level. Local surveillance systems are typically based on one or more of the following data sources: (*a*) OSHA 200 log, an important source of data for the BLS surveillance system; (*b*) in-plant medical records or logs; or (*c*) workers' compensation records. Analyses of surveillance data for the purpose of determining the magnitude of a problem sometimes also suggest a possible cause for the problem. Generally, further research or evaluation is then necessary to thoroughly explore the surveillance-generated hypothesis. Since resources for evaluating exposures and implementing possible prevention strategies are commonly limited, surveillance data identifying the magnitude of the problem should be used to allocate resources for further investigation and preventive activities.

The third goal of surveillance systems is to track trends in the number of workers exposed to occupational hazards, or the number of workers with injuries, disorders, and diseases over time. One of the major uses of this trend data is to qualitatively evaluate the effectiveness of prevention activities. However, an important limitation of surveillance data is that changes in the rate of disorders may be due to changing levels of exposure or changes in the reporting of disorders independent of their level of occurrence. Despite the limitations of

TABLE 33-4. INDUSTRIES WITH HIGH AND LOW RATES OF DISORDERS ASSOCIATED WITH REPEATED TRAUMA, 1990

Industry	*Standard Industrial Classification*[a]	*Incidence Rate*[b]
Meat packing plants	2011	1336
Poultry slaughtering	2015	696
Manufacturing refrigerators	3632	473
Grocery stores	5411-9	2
Manufacturing electronic components	3671-9	2

From Bureau of Labor Statistics. US Department of Labor. November 1991.

[a]Based on a classification system for dividing the economy into different industries, this system is described in *Standard Industrial Classification Manual* (1987). Technical Committee on Industrial Classification, Chairperson: Paul Bugg.

[b]Number of cases per 10,000 full-time workers (40 hours per week for 50 weeks per year).

surveillance data systems, the opportunity they provide for evaluation of preventive efforts is often unique because, while feasible, large-scale research evaluations of intervention programs are difficult and costly to undertake. Surveillance evaluations may involve occupational exposures (hazard) and health outcome data.

Hazard Surveillance

The most effective workplace surveillance system will have a health and a hazard or exposure component. While hazard surveillance may be less common than health surveillance, it is vital. Hazard surveillance provides the opportunity to identify and intervene on hazardous exposures before an injury or disorder develops. When hazardous exposures involve only small groups (less than 25) of workers, most serious work-related health problems will be infrequent. The determination that a disease is work related will often be difficult based on health surveillance alone. In contrast with hazard surveillance data, hazards may be readily identified regardless of the number of exposed workers. The ability of a hazard surveillance system to identify hazardous exposures is less dependent on the number of exposed workers but rather depends on the overall accuracy of methods used to identify the nature and the intensity of the exposures. As with health surveillance information, hazard surveillance information will frequently need validation with more precise data. Hazard surveillance information can be collected by worker interview, walk-through inspections, or environmental sampling. As a result of hazard surveillance and other health surveillance information, jobs can be prioritized for more sophisticated or intensive evaluation to identify hazardous exposures. The purpose of the more sophisticated evaluation is to precisely assess the nature of the exposures and to evaluate possible methods to reduce exposures.[15] Sometimes hazardous exposures identified by the hazard surveillance activities will be so clearly hazardous and ways to reduce the level of exposure will be so obvious that the more sophisticated evaluation will be unnecessary.

With regard to precision in estimating the level of exposure, hazard surveillance activities occupy one end of a spectrum, with sophisticated job analyses at the other end of the spectrum. Hazard surveillance assessments should be completed quickly with modest accuracy by trained nonprofessionals, while sophisticated job analyses will require considerably more time to be completed but will be more accurate in the identification of risk factors. Either approach can be used to assess changes in the level of job exposures after a job has been changed for any reason.

Characteristics of Successful Health Surveillance

One of the features of an effective surveillance program is the use of a standard coding system for recording health outcomes. Standardized coding leads to more homogeneous disease categories. Surveillance systems generally have to be as cost effective as possible to be widely used. The principal advantage of using existing data sources such as workers' compensation records is low cost. Supplementing an existing surveillance system with an additional component such as symptom questionnaires should be considered when observations of the workplace suggest that there are potentially hazardous common exposures, but the existing surveillance data suggests that there are no problems.[13,14] The absence of problems will commonly occur for two reasons: the exposures are not high enough to cause any health complaints and underreporting. Underreporting of problems is likely to be more common where there are obstacles or discentives to the reporting of a possible disorder to supervisors or health professionals. For example, if an organization gives awards to departments without lost time injuries or work-related disorders, either supervisors or coworkers may discourage reporting. In the second situation, more active collection of surveillance data is indicated when there is simply no existing health surveillance information to determine if a problem exists but substantial exposures are common. For example, in many sectors of the economy, OSHA logs are not required.

One of the most common types of actively sought information is the presence of symptoms by use of a questionnaire. Symptom questionnaires may be administered by a number of methods.[13,14] The analysis of questionnaire data requires some training. Generally, the case definition must be defined prior to analysis. The purpose of these definitions is to improve the uniformity or consistency of the data collected, thereby improving the quality of the surveillance data. The goal is to ensure that cases have a common set of characteristics. Symptom questionnaires are generally not used to establish a clinical diagnosis supplemented by other more definitive health examinations.

The analysis of health surveillance data is conceptually similar to the analysis of epidemiological research data.[13] In the analysis of surveillance and epidemiological data, issues of misclassification and random or systematic errors in assessing either exposures or health outcomes should be considered. Errors due to misclassification are likely to be more common in surveillance data compared to epidemiological research data. When the goal of the analysis is to determine if a specific group of workers or jobs is associated with an elevated risk, use of an internal comparison reference group from the same organization rather than some external comparison is useful since the identification of cases within an organization and their reporting are likely to be similar. While random and systematic errors in surveillance data limit the conclusions that can be drawn, these limitations are less important since the goals of the surveillance analyses are less rigorous than in epidemiological research, where the goal is to test a specific hypothesis. Changes in requirements for case reporting may occur over time in surveillance systems, making longitudinal analyses difficult. Surveillance analyses should be interpreted less quantitatively and more qualitatively. Frequently in the analysis of surveillance data, the variation in risk between jobs, departments, or industries is so large that real differences in risk can be characterized by simple statistical analyses and are unlikely to be explained principally by errors in the classification of disease, confounding factors, or random errors. Nevertheless, surveillance data should always be interpreted cautiously, given its limitations. The goal of the analysis of surveillance data is to trigger further investigation if a problem is detected, not to definitively establish its presence or absence.

► CONCLUSIONS

One of the most common purposes of workplace health examinations and one that is most relevant to improving the health of the workforce is to identify toxic health effects at an earlier stage than they would be detected without the examination. This type of screening program is often initiated with a baseline examination and then followed with periodic follow-up examinations. The goal of this type of program is secondary prevention.

Health examinations are also performed in workplaces for other purposes. For example, the most common purpose of the preplacement medical examination, which occurs after an offer of employment has been made but before an individual is placed on a specific job, is to determine if the individual has significant physical or mental impairment that would preclude the individual from performing specific essential duties related to a particular job. Most questionnaires and medical tests that are commonly included in occupational screening programs have not been extensively evaluated for their ability to detect those with and without adverse health effects. When employees are found to have adverse work-related health effects, actions should be undertaken to identify workplace exposures that are hazardous, and steps should be undertaken to reduce the excessive exposures.

These efforts to evaluate exposure should be extended beyond the individual with abnormal test results to other workers with similar exposures. The test must be free of any significant risk for the screened subjects since the main use of the test is to identify subclinical disease or diseases before an employee would normally seek health care. The test must also be acceptable to the screened population. The issue of who has access to the medical information collected in a workplace surveillance or screening program is a major ethical concern. Ethical codes have been developed by both the American College of Occupational and Environmental Medicine and

the International Commission on Occupational Health.[3,4] Rothstein has proposed a Bill of Rights of Examinees.[1]

The most common surveillance systems used to evaluate occupational health and injury problems are based on the OSHA 200 log data, occupational health service (in-plant medical records), periodic medical examinations, or workers' compensation records. These common surveillance systems have been used to achieve many surveillance goals.

There are three principal surveillance goals. The first goal of surveillance is the identification of new or previously unrecognized problems. The second goal is to determine the magnitude of the occupational health injury or exposure problem either at the national, state, or local level. The third goal is to track trends in the number of workers exposed to occupational hazards, or the number of workers with injuries, and diseases over time. The evaluation of preventive activities is often feasible using surveillance data. While surveillance data needs to be interpreted cautiously given its inherent limitations, surveillance data often correctly identifies hazardous working conditions and can be used successfully to monitor their elimination.

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