

Surveillance and Health Screening in Occupational Health

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► INTRODUCTION

This chapter will discuss surveillance and health screening in occupational health and the common principles that guide program performance.

► SURVEILLANCE IN OCCUPATIONAL HEALTH

Surveillance in occupational health, as in other public health endeavors, involves the systematic and ongoing collection, evaluation, interpretation, and reporting out of health-relevant information for purposes of prevention. Surveillance can help establish the extent of a problem, track trends, identify new problems or causes, help set priorities for preventive interventions, and provide the means to evaluate the adequacy of the interventions. Surveillance programs can focus on an enterprise, an industry, or on the general population.

At the national level, surveillance data can be used to identify high-risk industries. 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.¹ The number of occupational illnesses and injuries is collected from each surveyed employer. This system is periodically revised to improve the classification of occupational diseases and to collect more information about the etiology of diseases and injuries.

The most effective workplace surveillance systems have both health and hazard or exposure components. 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. Both health hazard surveillance efforts are often characterized by their speed and practicality. Indications of abnormality generally need confirmation or further validation.

Health Surveillance

Health surveillance within an enterprise often involves analysis of the information gathered in baseline or pre-placement examinations and periodic screening testing. In addition, administrative records such as health insurance data, work absence records, workers' compensation claims, or worksite "incident reports" may provide insight into the health of the workforce. Records from poison control centers and from emergency room visits have been used for population-based occupational injury surveillance as well. Population-based workforce data can be analyzed for rates of disease or injury, so areas of unusual

occurrence within an enterprise, a community, or a country can be identified and investigated. Some conditions such as silicosis are so characteristically occupational that all cases should be investigated. These are known as sentinel events.²

Hazard Surveillance

Hazard surveillance (systematic monitoring of the workplace for hazardous exposures) is an important part of occupational surveillance activities. The identification of potentially harmful levels of exposure to hazardous substances or conditions before work-related diseases or injuries have developed or are recognized provides the opportunity for prevention through workplace redesign and implementation of engineering or administrative controls to reduce risk.

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 intensive evaluation to identify hazardous exposures. The purpose of the more complete evaluation is to precisely assess the nature of the exposures and to evaluate possible methods to reduce exposures. Sometimes, exposures identified by hazard surveillance will be so clearly hazardous and ways to reduce the level of exposure will be so obvious that more sophisticated evaluation will be unnecessary.

In most contemporary U.S. workplaces, when hazardous exposures involve only small groups of workers, serious work-related health problems are infrequent. It is particularly difficult to detect increased occurrence of common diseases that may be caused by occupational and nonexposure factors (alone or in combination) 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 depends on the overall accuracy of methods used to identify the nature and the intensity of the exposures:

► TYPES AND PURPOSES OF WORKPLACE HEALTH EXAMINATIONS

Pre-placement Examinations

After an offer of employment is made, but before or soon after work is initiated, workers may undergo selective or comprehensive health examinations. Ethically and legally, these examinations may not be used to exclude the worker from employment but may be used to guide proper placement for the worker, identify educational and training needs, assist in the selection of personal protective equipment,

and identify necessary work-station design or other kinds of accommodations needed for workers with disabilities. These examinations are more likely to take place when known hazardous exposures are anticipated, and some are mandated by legal health standards. For example, each coal miner is mandated by the Mine Safety and Health Act (MSHA) to have a chest radiograph prior to starting underground coal mine work. Pre-placement examinations provide an opportunity for education concerning work hazards and an orientation to occupational health services.

Medical Screening

Medical screening examinations attempt to identify health effects from work exposures at an earlier stage than they would ordinarily be detected by the worker without the examination. In general, after a positive screening test is confirmed, available, acceptable interventions must be able either to reverse the detected abnormality or to reduce the severity of the outcome. Screening is intended to benefit the screened individuals. Screening programs may also indirectly benefit other similarly exposed workers if the detection of work-related health effects trigger an investigation of the workplace and efforts to reduce hazardous exposures or change unsafe working conditions. If large groups are tested periodically, the resulting data can be analyzed to identify group trends as part of a surveillance program as described above. Screening examinations may include administration of questionnaires, physical examinations, and clinical tests such as tests of pulmonary or liver function. Screening examination should be voluntary and are intended to benefit the individual worker who is screened. Therefore, the screening tests used in these one-time or periodic examinations should be evaluated to ensure that the tests are effective for screening objectives and pose minimal risk.

Biological Monitoring

Biological monitoring involves 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 absorption. It is a common adjunct to medical monitoring or screening. This approach to exposure assessment is particularly useful when dermal absorption is possible. Biological monitoring should not be used to replace careful assessment of exposure conditions by other effective methods such as environmental air measurements.

Susceptibility Screening

Another type of screening, where ethical issues are particularly important, is the attempted identification of individuals who may be more susceptible to workplace toxins from individual characteristics such as genetic or phenotypic factors common in the general population. There is currently no regulatory mandate to perform any such testing, and the performance of examinations for genetic or other susceptibility factors raises significant legal issues. Few validated tests are currently available, and the predictive value of proposed tests is limited. Employers continue to have a legal and ethical responsibility to maintain a workplace free of recognized hazards for the entire workforce, not just the least susceptible.

General Health Appraisal

Some employers offer limited or comprehensive health examinations at work as a component of an overall effort to promote employee health. These examinations may include structured questionnaires (investigating diet, exercise, tobacco use, etc.) and medical testing (e.g., blood pressure, cholesterol, BMI calculation) to appraise risk and assist in general health promotion counseling. Although general health appraisal examinations have traditionally been separate from examinations focused on occupational risk factors, there is growing interest in exploring the value of integrating programs for protection of the workforce from occupational hazards with efforts at individual health promotion.³

TABLE 40-1. SELECTED EXPOSURES WITH OSHA-MANDATED MEDICAL EXAMINATIONS

Acrylonitrile
Arsenic, inorganic
Asbestos
Benzene
Blood-borne pathogens
Cadmium
Coke oven emissions
Ethylene oxide
Noise
Lead

Legally Mandated Medical Examinations

Some OSHA and MSHA standards mandate medical examinations as part of a comprehensive approach to prevention. For example, people exposed to asbestos or cotton dust in general industry must be offered periodic pulmonary examinations; lead-exposed workers must undergo periodic blood lead analyses; and workers exposed to excessive noise must be offered periodic audiometry. Examinations either focus on the primary "target organ" of the toxin, as with asbestos, or involve biological monitoring as with lead. Table 40-1 lists selected substances from among approximately 30 OSHA standards requiring medical screening or surveillance. Generally, 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).⁴ 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. NIOSH recommends health examinations for a broader list of agents than those covered by OSHA or MSHA standards.

► ETHICAL ISSUES IN HEALTH EXAMINATIONS IN THE WORKPLACE

The relationship between the health-care provider and the examinee in occupational settings is different from 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. 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.⁵ Ethical codes have been developed by professional organizations such as the American College of Occupational and Environmental Medicine (ACOEM) and the International Commission on Occupational Health (ICOH).^{6,7} Rothstein has proposed a Bill of Rights of Examinees.⁵ 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.⁸ All of these codes recognize the need to maintain the confidential nature of most medical-screening information.

Legal responsibilities to maintain medical information confidentially is reinforced by the Americans with Disabilities Act (ADA)⁹ and mandated by the Health Insurance Portability and Accountability Act (HIPAA).¹⁰ All medical information must be collected confidentially and stored in separate, secure medical files. Under ADA, management may be informed of workers' restrictions that limit their ability to perform the job duties. In addition to ADA and HIPAA, 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 OSHA

TABLE 40-2. CRITICAL INFORMATION CONCERNING MEDICAL EXAMINATIONS IN THE WORKPLACE

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

Data from Rothstein MA. Legal and ethical aspects of medical screening. *Occup Med.* 1996;11(1):31-9.

mandates various pre-placement and periodic medical examinations that employers must offer employees, the employees have the right to refuse to participate in these OSHA-mandated examinations unless participation is specified in an employee-employer contract. Maintaining the confidentiality of medical data is not only important from legal and ethical perspectives but is critical in facilitating the employee's participation in the program.

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 effort³ (Table 40-2).

► OTHER PROGRAM DESIGN ISSUES

The value of preventive examinations at work depends on a number of program planning and design elements.¹¹ The purpose (or purposes) of any program should be clear both to those performing examinations and to the intended beneficiaries. As a rule, programs for screening and surveillance respond to the presence of hazardous exposures in the workplace and focus on workers most likely to be exposed. Examinations should be selected to identify early evidence of significant health effects that might result from these exposures. Tests of reasonable sensitivity, specificity, and predictive value must be available, and a process for confirmation of abnormal tests and medical follow-up incorporated into the program. Most questionnaires and some of the 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 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). Tests 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. Tests must also be acceptable to the screened population.

OSHA or MSHA standards or NIOSH recommendations can help guide program development. International organizations such as the International Labor Organization (ILO) and World Health Organization (WHO) have developed materials that are useful in designing occupational health surveillance programs.^{12,13} Table 40-3 summarizes design elements for workplace health examinations.

An individual is responsible for oversight of the program and should be identified. Trained and qualified technical and professional staff should be performing all components of the examinations. Adequate maintenance and calibration of equipment is necessary to obtain valid test results that can be compared with one another over time to track health status in individuals and groups. Individually identifiable health information must be stored in a way that meets legal and ethical obligations to protect confidentiality.

TABLE 40-3. 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

Selection of tests and test frequency can be a challenge. Professional organizations may provide guidelines to assist in equipment selection and test performance,¹⁴ and comprehensive health regulations or guidelines in some instances specify test standards and frequency. When programs are being designed *de novo* and are not in response to a legal mandate, tests should be performed frequently enough to identify problems that may arise between test cycles sufficiently early to intervene effectively and should also take into consideration the likelihood that not every worker will participate in each test cycle. Interpretation of changes in test results in any individual over time must take into consideration expected fluctuations in testing in individuals or populations as well as variability related to equipment, technician performance, etc. Test selection and frequency is often resource dependent.

The adequacy of some surveillance programs attempting to track trends or determine the success of interventions depend on reasonable levels of participation of the workforce. If a program provides workers with the type of information listed in Table 40-2, a high level of participation is more likely. Privacy and confidentiality must be assured. Consent to any testing must be provided, and all programs must be free of any hint of coercion. Individuals who participate in programs for medical screening and surveillance should be given their own individual test results and counseling should be available to provide answers to any resultant questions and advice on any follow-up that might be appropriate. Participants should also have access to the results of analyses of group data and be informed of any actions taken in response to problems identified.

► DATA ANALYSIS

Effective health screening and surveillance programs depend on data analysis, although this analysis does not need to be sophisticated. In some instances, confirmation of any occurrence of an abnormal potentially occupational condition such as tuberculosis in a health-care setting should immediately stimulate further evaluation and response. In other settings, calculation of rates and analysis of trends is needed to target work areas requiring intervention. Screening and surveillance can identify problems but do not prevent them. The analysis of the data and the response to findings are critical steps for reducing the burden of disease and injury in individuals and groups.

One of the features of an effective surveillance program is the use of a standard coding system for recording health outcomes. Standardized coding permits more homogeneous disease categories comparable across an industry or among industries with common exposures. For example, the ILO disseminates a standardized method for classification of chest x-rays for the presence of pneumoconiosis¹⁵ and the

WHO disseminates an International Classification of Diseases, facilitating common coding of medical records.¹⁶

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.

The apparent absence of problems will commonly occur for two reasons: the exposures are not high enough to cause any health complaints or underreporting. Underreporting of problems is likely to be more common where there are obstacles or disincentives 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. 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.

Symptom questionnaires are used frequently for workforce surveillance and may be administered by a number of methods. 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 unless supplemented by other more definitive health examinations.

The analysis of health surveillance data is conceptually similar to the analysis of epidemiological research data.¹⁷ 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 with 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 the identification of a possible problem than in hypothesis-testing epidemiological research. Changes in requirements for case reporting may occur over time in surveillance systems, making longitudinal analyses difficult.

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.

The magnitude of the occupational injury or disease problem can be estimated at the national, state, or enterprise 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;¹⁸ (b) in-plant medical records or logs; or (c) workers' compensation records. Analytic methods such as capture-recapture methods using different data sources to examine the same outcome in the same population can be helpful in improving the validity of estimates of the magnitude of disease occurrence.¹⁹

Analyses of surveillance data for the purpose of determining the magnitude of a problem may suggest a possible cause for the problem.

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 guide resource allocation for further investigation and preventive activities.

The goal of many 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. A major use of 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 reporting of disorders independent of their level of occurrence. Despite the limitations of surveillance data systems, the opportunity they provide for evaluation of preventive efforts is often unique because large-scale research evaluations of intervention programs are difficult and costly to undertake.

► CONCLUSIONS

Occupational health surveillance can contribute to improved prevention of occupational disease and injury. Health examinations at work are the "inputs" for programs aimed at early identification of adverse effects to reduce disease in individuals and for programs of surveillance designed to identify new hazards, track trends, and evaluate the adequacy of interventions for groups of workers. Hazard surveillance is another significant element in comprehensive occupational disease and injury prevention efforts. The development and conduct of any successful program that includes health examinations must address critically important ethical issues including those of worker autonomy and confidentiality. The results of health examinations and hazard information, thoughtfully analyzed, can help target preventive interventions. Surveillance systems can contribute to prevention but do not, in themselves, prevent disease or injury. This is done through the recognition and control of hazardous exposures at work.

► REFERENCES

1. U.S. DOL. BLS Home Page. Injuries, Illnesses, and Fatalities. Accessed September 21, 2005 at <http://www.bls.gov/iif/home.htm#tables>.
2. Rutstein DD, Mullan RJ, Frazier TM, et al. Sentinel events (occupational) for physician recognition and public health surveillance. *Am J Pub Health*. 1983;73:1054-62.
3. Sorensen G, Barbeau E. Steps to a Healthier U.S. Workforce: *Integrating Health and Safety and Health Promotion: State of the Science*. 2004 Accessed September 21, 2005 at <http://www.cdc.gov/niosh/steps/pdfs/NIOSH-post-symprevision.pdf>.
4. Jones DL. Occupational health services and OSHA compliance. *Occup Med*. 1996;11(1):57-68.
5. Rothstein MA. Legal and ethical aspects of medical screening. *Occup Med*. 1996;11(1):31-9.
6. American College of Occupational and Environmental Medicine. *Code of Ethical Conduct*, ACOEM, Arlington Heights 1993 Accessed September 21, 2005 at <http://www.acoem.com/code/default.asp>
7. ICOH. *International Code of Ethics for Occupational Health Professionals* (Rev 2002). Rome, Italy, 2002. Accessed September 21, 2005 at http://www.icoh.org.sg/core_docs/code_ethics_eng.pdf
8. American College of Occupational and Environmental Medicine. *ACOEM Position on Medical Surveillance in the Workplace*. American College of Occupational and Environmental Medicine 1989 Report ACOEM, Arlington Heights.
9. U.S. Department of Justice. ADA Home Page. Accessed September 21, 2005 at <http://www.usdoj.gov/crt/ada/adahom1.htm>
10. HHS Office for Civil Rights. HIPAA Home Page. Accessed September 22, 2005 at <http://www.hhs.gov/ocr/hipaa>

11. Maizlish NA, ed. *Workplace Health Surveillance: An Action-Oriented Approach*. New York: Oxford University Press; 2000.
12. ILO. *Technical and Ethical Guidelines for Workers' Health Surveillance, Occupational Safety and Health Series No. 72*, Geneva, 1998. Accessed September 21, 2005 at <http://www.ilo.org/public/english/support/publ/pindex.htm>
13. Wagner GR. *Screening and Surveillance of Workers Exposed to Mineral Dusts*. World Health Organization: Geneva; 1996.
14. Miller MR, Hankinson J, Brusasco V, et al. Standardisation of spirometry. No. 2 in series: ATS/ERS task force: standardization of lung function testing. *Eur Respir J*. 2005;26:319-38. Accessed on September 22, 2005 at <http://www.thoracic.org/adobe/statements/pft2.pdf>
15. International Labour Office. International classification of radiographs of pneumoconiosis. In: *Occupational Safety and Health Series, No. 22*. 2000 ed. Geneva: International Labour Office; 2002.
16. WHO. *International Statistical Classification of Diseases and Related Health Problems. 10th Revision Version for 2003*, Geneva, 2003. Online version accessed September 21, 2005 at <http://www.who.int/classifications/icd/en/>
17. Checkoway H, Pearce N, Kriebel D. Chapter 8: Occupational health surveillance. In: *Research Methods in Occupational Epidemiology*. 2nd ed. Oxford University Press: New York; 2004.
18. U.S. Department of Labor, OSHA. *Occupational Illness and Injury Recording and Reporting Requirements. Standard Number 1904; 1952. Final Rule*. U.S. Federal Register 66:5916-6135. January 19, 2001, accessed September 21, 2005 at http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=FEDERAL_REGISTER&p_id=16312
19. Rosenman KD, Reilly MJ, Henneberger PK. Estimating the total number of newly-recognized silicosis cases in the United States. *Am J Ind Med*. 2003;44:141-7.