Surveillance and Occupational Health

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This report explains the basics of two important uses of surveillance data: determining the magnitude of a specific occupational health or injury problem and examining temporal trends to determine whether the problem is increasing or decreasing. Types of data available for the purpose and some of their strengths and weaknesses are described. The utility of surveillance data is illustrated with examples from surveillance of acute injuries, musculoskeletal disorders, lead overexposures, and hazard surveillance data sets. Increasingly, surveillance systems may be used to evaluate the effectiveness of interventions. Surveillance is most important in times of rapid change in the economy and when resources for prevention may be limited. Both conditions are common in the world today. *Key words:* surveillance; health outcomes; sentinel events.

INT J OCCUP ENVIRON HEALTH 1999;5:26–29

The primary purpose of this report is to provide examples of two important uses of surveillance data: determining the magnitude of a specific occupational health or injury problem and examining temporal trends to determine whether the problem is increasing or decreasing. A useful starting point is to define 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).[1] This definition broadens the traditional focus on health outcomes to include hazard surveillance, which consists of either information about the number of workers exposed to a specific hazard or environmental measurements of the level of exposure.

Health outcome surveillance systems have traditionally used two types of data. The first is a source of case reports without definite information about the size of the population at risk (the cases are usually called sentinel health events). The second is a source of cases that includes information about both the number of cases and the size of the population at risk.[2] In the United States and England, a wide range of sentinel events have been shown to be useful additions to existing surveillance systems.[3–6] They include inhalation and burns, lead, carbon monoxide, and pesticide over exposures, and a variety of disorders, including carpal tunnel syndrome, dermatitis, asthma, and silicosis. These sentinel health events show promise in detecting old unresolved hazards and identifying new hazards that are major problems in specific industries or geographic regions.[6] In the United States, these systems have been state-based. In one state, dermatitis surveillance demonstrated the importance of exposure to fiber-reinforced plastics, and in another state, asthma surveillance demonstrated the importance of exposure to isocyanates and metalworking fluids.[5,6]

Advocates for occupational surveillance activities argue that surveillance data should directly influence prevention and research priorities within the public and private sectors. The current debate in the United States about the magnitude of the work-related musculoskeletal disorders, and whether there are effective preventive interventions, is in part fueled by surveillance data that indicate that work-related musculoskeletal injuries and disorders (exclusive of those that result from acute traumatic events) are the most common occupational health problems other than acute traumatic injuries. Each year, the Bureau of Labor Statistics surveys 250,000 workplaces across the country. Some information is collected about the type and cause of each disease or injury that results in the worker's either being absent from work or being unable to perform normal job duties. The two most common causes of days away from work in 1995 were overexertion such as may occur with lifting heavy objects and being struck by or against an object or machinery.[7] The rate for overexertion injuries or disorders was 6.9 per 1,000 workers, while the rate for being struck was 5.1 per 1,000 workers. Examples of injuries or disorders in the overexertion category include low-back injuries or disorders from lifting and carpal tunnel syndrome from repetitive work activities. The second most

Received from the National Institute for Occupational Safety and Health, Cincinnati, Ohio.

Presented at the ICOH symposium on Occupational Health and Epidemiology in 1997.

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common category is acute traumatic injuries from being struck by or against objects such as tools or working materials. These two causes were associated with 47% of the injuries and disorders, resulting in a total of approximately 950,000 injured workers. This type of information about the magnitudes of specific occupational health and injury problems should be used to set priorities for prevention and research activities.

Determining Temporal Trends

Another important use of surveillance data is evaluating the progress toward the elimination or reduction of occupational diseases, injuries, and overexposures. This use of surveillance information may be more common in the future as attention increasingly focuses on whether interventions are effectively reducing injuries and diseases. Particularly after an intervention program at a national level is initiated, analysis of surveillance data may be one of the few ways to conduct an evaluation of the intervention, because the collection of analytic epidemiologic data often is very expensive. In interpreting the surveillance data, consideration should be given to the limitations of the surveillance system and data. Common limitations include misclassification of type or level of exposure and disease, gaps in the reporting/capture of cases, and differences between reporting sources with respect to ascertainment methods and case criteria.

Despite these limitations, surveillance information from the United States provides a few examples of temporal trends that demonstrate a possible reduction in the level of exposures or reduction in the rate of disease or injury. The rate of fatal injuries to workers in the United States has declined approximately 40% since 1980.[8] The U.S. Census of Fatal Occupational Injuries is an example of a surveillance system that has information about both the number of cases and the size of the population at risk. Some will argue that these downward trends reflect not the beneficial impact of either occupational health regulation or scientific research but rather larger societal trends. Other examples of a downward secular trend are the rates of overexertion injuries or disorders and acute traumatic injuries from being struck by or against objects. The rate for both causes dropped about 17% from 1992 to 1995.[7] The surveillance system was changed in 1991, so earlier rates cannot be directly compared with the recent rates.

An example of a sentinel-event system (which lacks information about the population at risk) is the Adult Blood Lead Epidemiology and Surveillance program (ABLES), which monitors laboratory-reported elevated lead levels among adults in about half of the states of the United States. In this data set, a small decline is apparent during the first few years of the system, from 1993 to 1996; however, it is unclear whether the decline has continued since then.[9] This decline may reflect decreased levels of exposure, fewer numbers of exposed workers in the lead industries, or possibly less effective surveillance. Nevertheless, there is some reason to believe that the preventive efforts triggered by the follow-back activities initiated by the ABLES system when an elevated blood lead level is identified are contributing to the decline in the number of workers with elevated blood leads.[9,10] The ABLES system has been relatively easy to develop. All of the laboratories in a geographic region simply report all of their elevated blood lead cases to the public health department. In any given area, there are only a limited number of laboratories performing blood lead analyses. Taiwan has established a similar system.[11] Without detailed information about the coverage and effectiveness of each surveillance system in identifying heavily exposed workers, it is difficult to interpret the data that suggest that exposures may be lower in Taiwan. The percentage of blood levels over 40 μg/dL in the United States data is 22%, while it is lower in Taiwan, at 10%.

While the overall secular trend is downward for most occupational injuries and illnesses, identifying the exceptions may provide insight into the need for more effective prevention strategies. As discussed earlier, the overall secular trend for fatal injuries is for declining rates. One recent analysis focused on whether the overall economic conditions of specific industries were related to the changes in the rates of fatal injuries over time. Industries were divided into two groups: those with declining workforces (presumably related to economic difficulties) and those with expanding workforces. Not unexpectedly, the rate of fatal injuries in the 1980s declined 6.8% per year in the manufacturing industries with expanding labor forces, while manufacturing industries with declining labor forces experienced a 9.6% increase per year.[12] In one of the industries with a shrinking workforce, a large fire killed many workers. Even with this one tragic fire removed from the data set, the declining manufacturing industries still had a 3.1% increase per year. The reasons for the disparity in the rates is not clear, but deserves further study to determine whether there are reliable measures that can prospectively identify industries at risk of increasing fatality rates.

Another example of an industry where the injury rate is increasing while a similar industry has a declining rate is the residential care industry.[7] This industry includes half houses and homeless centers. In the nursing home industry, which is similar to the residential care industry, the rate of assaults on workers has declined 20%; in contrast, in the residential care industry the rate has risen 40%. Both industries have high rates of assaults on workers. A systematic approach to identifying industries and occupations with increasing rates of injuries and disorders (particularly where the overall trend is downward) can help identify failures in current prevention efforts.

TABLE 1 Silica Samples' Percentages over the Permissible Exposure Level (PEL), 1979–1994*

Sampling Period	% of Samples > PEL (No. of All Samples)	
	Mining	General Industry
1979–1984	16.9 (79,615)	27.2 (7,911)
1985–1992	16.1 (100,463)	21.6 (6,534)
1993–1994	10.4 (38,960)	18.2 (858)

*Adapted from Tables 3–12 Silica: Number of MSHA inspector samples percent exceeding the permissible exposure limit (PEL) and average severity levels (Avg. Sev.) by state, 1974–1994; and Tables 3–13 Silica: Number of OSHA inspector samples, percent exceeding the permissible exposure limit (PEL) and average severity levels (Aug. Sev.), by state, 1979–1994. U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health, Division of Respiratory Disease Studies. Work-Related Lung Disease Surveillance Report 1996. DHHS (NIOSH) Publication No. 96-134.

Perfecting methods that use surveillance data to investigate interventions could become an important collaboration for social scientists and epidemiologists. Because policy changes are often the subject of years of intense debate, figuring out when the policy process first impacts practice will be a challenge. Therefore, such studies may need to examine five to ten years of surveillance information. In the United States, increased enforcement activities for work-related musculoskeletal disorders began in the late 1980s, and broad policy initiatives at the federal level began in 1992, which resulted in the release of a preliminary draft proposal in 1995. The policy debate continues at the national and state levels. As a result, deciding which events might have contributed to the decline observed in the rate of overexertion injuries from 1992 to 1995 will be difficult. Of course, it is possible that the decline is totally unrelated to the policy debate.

Hazard Surveillance

Hazard surveillance should be considered an important part of occupational surveillance activities. As in the case of health data, exposure information can be used both to set priorities and to evaluate trends. At a national level, hazard surveillance is often a costly activity. NIOSH has been able to conduct representative hazard surveys only twice in the last 30 years, most recently during 1981–83.[13] Nevertheless, the data from these surveys are still useful in informing us about the most common hazards.[13] The National Occupational Exposure Survey (NOES) used trained nonprofessional observes to conduct walk-through surveys of over 5,000 firms. The most common full-shift exposures were to continuous noise and repetitive handwork.[14] The ubiquity of repetitive handwork helps explain why it is both an important and a contentious policy issue. The most frequent chemical or dust exposures involved about 400,000 workers. The agents to which they were exposed were isopropyl alcohol, sawdust (wood, soft or hard), and metalworking fluids. NIOSH has recently published a criteria document, Criteria for a Recommended Standard Occupational Exposure to Metalworking Fluids.[15] This example illustrates that hazard surveillance information can identify exposures that should be targeted for further research and preventive strategies directed toward reducing exposures.

Another database is also available as a source of hazard surveillance information. It catalogs the environmental samples collected during enforcement inspections by the regulatory occupational health and safety agency in the United States, the Occupational Safety and Health Administration (OSHA).[16] This database is not as comprehensive as the NOES database, nor is it necessarily representative of U.S. industry. It largely contains information about the specific chemicals for which OSHA has standards. However, it does have some information about levels of exposure. Samples have been entered into this database since 1979. With this database, one can examine temporal changes in exposure levels. For example, the NIOSH recommendation for exposure to metalworking fluids is 0.4 mg/m^3 for thoracic particulate matter (or 0.5 mg/m^3 for total particulate mass). The OSHA database shows that the percentage of total aerosol exposures of less than 0.5 mg/m^3 increased from 37% before 1980 to 73% after 1990.[17] Thus, assuming that OSHA inspection and sampling practices remained similar during the decade, the trend for the level of exposure was downward.

In evaluating any surveillance database, it is important to consider potential sources of bias. One might expect that this data set of environmental samples from enforcement inspections would not be representative of all exposures and would be biased toward containing disproportionately the highest exposures. However, a recently completed NIOSH nationwide survey of 60 plants suggests that the OSHA data set is not highly biased. The NIOSH survey found that approximately 70% of the sample results were below 0.5 mg/m^3 for inhalable particulate samples.[17] The sampling strategies used to identify plants for environmental sampling for the two data sets were different, yet the percentages of samples below the proposed exposure limit were similar. Both are likely to be representative of the current levels of exposure.

Another example of a downward exposure trend from hazard surveillance information is the level of silica exposure over the last two decades in the non-mining and mining sectors of the United States economy (Table 1).[18]

The results from general industry in the most recent period (1993–1994) may not reflect a significant drop in the level of exposure, because even though the percentage of the samples that were below the permissible exposure level (PEL) was lower than it had been in earlier periods, the absolute levels in the samples with results above the PEL were very high. There is one possible explanation for this increase in the level of the samples. The number of samples per year decreased by 50% in 1993–1994, perhaps leading to focusing some of the sampling efforts in a few very highly exposed workplaces. Hazard surveillance is critical in achieving two surveillance goals: determining the magnitude of a specific problem, and determining whether the magnitude of the problem over time is diminishing or increasing. Hazard surveillance should be a very important part of any comprehensive occupational surveillance system, but often is not.

Surveillance is most important in times of change and when resources for prevention are limited. The pace of change in the world economy is rapid, and in some countries the numbers of industries exposed to international competitive pressures are growing. New industries are developing in countries where they previously did not exist, possibly creating new occupational health problems in these countries. The heightened competitive pressure may be changing working conditions in many existing industries, and this has the potential for the development of new occupational health problems or the recurrence of old problems. Effective surveillance systems permit the identification of the occupational health consequences of these changes, and, hopefully, the development of prevention strategies. The challenges worldwide are large. The WHO estimated that perhaps as many as 200,000 workers die each year from occupational injuries and diseases, and that these losses occur not on a battlefield but in the workplace.[19]

The authors' views on the utility of surveillance activities have been strongly influenced by many individuals at the National Institute for Occupational Safety and Health (NIOSH) in the United States. Colleagues who provided assistance and encouragement during the preparation of this paper included: William Halperin, Ruth Ann Jajosky, Boris D. Lushniak, Robert J. Roscoe, Leslie Stayner, and Gregory R. Wagner.

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