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Development of a National Occupational Exposure Survey and Database Associated with NIOSH Hazard Surveillance Initiatives

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NIOSH pioneered hazard surveillance in the workplace by designing and conducting the 1972 to 1974 National Occupational Hazard Survey (NOHS), the 1981 to 1983 National Occupational Exposure Survey (NOES), and the 1984 to 1989 National Occupational Health Survey of Mining (NOHSM). The databases developed from these three on-site surveys represent unique resources for associating potential chemical, physical and biological agents with industries and occupational groups. The data have been a primary source of information for NIOSH, regulatory agencies, health professionals, researchers, and labor organizations in establishing priorities for prevention strategies that include medical and engineering interventions, development of occupational standards, and the identification of research needs. Recognizing that the data from these surveys are becoming dated, a multidisciplinary team comprising members from various NIOSH research divisions was established to develop a hazard surveillance strategy for the Institute, including options for a national hazard surveillance survey and database. The proposed new hazard survey builds on lessons learned from the previous surveys, seeks opportunities to incorporate existing data from other sources, expands the scope of industries and hazards, and takes advantage of advances in data gathering, processing and dissemination technology. This article presents current considerations and recommendations for a new hazard survey and database.

Keywords Occupational Hazard Surveillance, Exposure Databases

Occupational exposure databases are valuable resources in the field of occupational health and safety and can include quantitative data, qualitative data, or both. While databases containing quantitative exposure measurements are preferred, those which contain qualitative information (i.e., potential exposure

based on an assessment where the level of exposure is not measured) can also serve as valuable resources to the occupational health and safety community. Between 1972 and 1989, NIOSH conducted three national surveys which yielded databases containing qualitative exposure information. The first two surveys—the 1972 to 1974 National Occupational Hazard Survey (NOHS) and the 1981 to 1983 National Occupational Exposure Survey (NOES)—were conducted in establishments regulated by the OSHAct.^(1,2) The third survey, the 1984 to 1989 National Occupational Health Survey of Mining (NOHSM), was conducted in mineral mines regulated by the MSHAAct.⁽³⁾ These surveys provided valuable information on potential exposures to chemical, physical and biological agents, based on whether the following two criteria for exposure guidelines were met: (1) the agent or tradenamed product must have been observed in sufficient proximity to the worker such that one or more physical phases of the agent or tradenamed product to be likely to enter or contact the body, and (2) the duration of the potential exposure must be for at least 30 minutes per week on an annual average or at least 30 minutes for 90 percent of the weeks of the work year.^(1–3) All three surveys were designed using a stratified random probability sample so as to be statistically representative of the respective covered industry sector(s) and to permit projections to the national level based on the survey results.

For each survey, data were collected using a standardized questionnaire and an observational facility walkthrough. The questionnaires were administered to management and elicited information on facility demographics, type of health, safety, and medical surveillance activities and resources, and use of exposure controls. The facility walkthrough enabled surveyors to inventory health-related agents to which workers were potentially exposed. Survey design and methods used in the NOHS, NOES, the NOHSM and their respective database structure, capabilities and limitations have been previously described in proceedings from the first conference on occupational exposure databases and elsewhere.^(4–6)

The databases developed from the NOHS, NOES, and NOHSM represent unique resources for linking observed

exposure agents with industries and occupational groups. The data from these surveys have been a primary source of information for NIOSH, regulatory agencies, health professionals, and labor organizations in establishing priorities for prevention strategies that include medical and engineering interventions, development of occupational standards, and the identification of research needs. The data from these surveys have also been linked to a variety of other databases. For example, data from the NOHS, NOES, and the 1989 OSHA National Survey of Personal Protective Equipment Usage were used to document trends in the use of hearing protection in general industry over the period 1972 to 1989.⁽⁷⁾

In the past, limited resources have largely kept further surveys from being conducted on a regular basis. Recognizing that the data from these surveys are becoming dated, combined with the increasing need for updated information by other federal agencies and the occupational safety and health community, NIOSH leadership recommended that a team be established to address the task of conducting a followup to these surveys. In December 1998, a multidisciplinary team comprising members from various NIOSH research divisions (hereafter called the Hazard Surveillance Team) initially met and over the next several months developed a working draft of a hazard surveillance strategy which presented options for, and enhancements to, an ongoing national occupational hazard survey and database. Representatives of the Hazard Surveillance Team met with key federal partners during separate meetings held in the spring and summer of 1999 to obtain input and comments on the draft. Additional input and comments on the draft were invited following presentations at a June 1999 NIOSH Board of Scientific Counselors meeting, a July open public meeting held in Washington, D.C., a September 1999 meeting of the National Advisory Committee on Occupational Safety and Health (NACOSH), a September 1999 NIH/NIEHS Human Exposure Assessment Workshop, and during internal NIOSH meetings held in Cincinnati, Morgantown, and Pittsburgh during the summer of 1999. Based on comments received at these meetings, the working draft was revised to include recommendations for an ongoing program of national surveillance of occupational health and safety hazards, and was titled *Hazard Surveillance Strategy for NIOSH*⁽⁸⁾ to reflect this more holistic approach to hazard surveillance. In the current draft, recommendations are provided for the following hazard surveillance initiatives:

- Ongoing activity of analyzing existing hazard surveillance data;
- Comprehensive, nationally representative hazard survey;
- Hazard surveys targeted by industry, occupation or hazard;
- Web-based resource providing access to hazard surveillance data, analyses, and related information;
- National occupational exposure database; and
- Standardized data collection instruments for assessing hazards.

This article focuses on options considered by the Hazard Surveillance Team for an ongoing hazard survey (i.e., nationally representative and/or targeted surveys), and plans associated with management and dissemination of survey data. It must be emphasized that the team views the current effort as an ongoing process; the proposal provided herein will probably undergo additional revisions and refinements.

OPTIONS FOR A HAZARD SURVEY

The Hazard Surveillance Team considered three options for an ongoing hazard survey. Two of the three options involve a comprehensive, broad-based national survey; the remaining option involves the conduct of hazard surveys targeted by industry or hazard. The two options for a broad-based national survey include: (1) an on-site hazard survey analogous to previous NIOSH hazard surveys, and (2) a telephone survey of management and workers. Relative to the on-site survey, two major methodological differences from previous surveys include more rigorous assessments of exposure (qualitative and limited quantitative assessment) and the addition of a survey of workers from each establishment to assess knowledge of potential hazards, safety and health programs, and organization of work. Regardless of the survey option selected, the new survey will build on lessons learned from the previous efforts, seek opportunities to incorporate existing data from other sources, expand the scope of industries and hazards, and take advantage of advances in data gathering, processing, and dissemination technology.

National On-Site Survey of Establishments and Workers

Overview

A national on-site survey is most analogous to the previous NIOSH hazard surveys. It is a comprehensive survey of workplace hazards and their controls in a nationally representative sample of workplaces in most industry sectors. Like the previous surveys, information would be collected by observations made at the workplace by trained surveyors and on-site interviews of management personnel. Similar information would also be gathered from employee representatives and workers which was not gathered in previous surveys. Unlike previous surveys, this option plans for periodic data collection so that up-to-date data would be continually available.

The survey would cover chemical, physical, biological, ergonomic, and safety hazards and would obtain information on exposures, control technology, personal protective equipment, safety and health programs, worker demographics, use of contingent workers, organization of work, and health and related outcomes. Using these data, NIOSH would routinely produce descriptive analyses such as summary statistics on the number, levels, trends, and distribution of exposures and controls by industry, occupation, process, and select demographic variables; the numbers and distribution of workers under select safety and health program characteristics; select comparisons of exposure, safety and health program, and health outcome data;

identification of newly recognized and emerging hazards and hazards of substantially declining frequency or levels.

Goals

The new hazard survey would be an ongoing, systematic effort to collect, analyze, interpret, and disseminate data on the hazards faced by workers in the United States. The specific goals of the survey are as follows:

- Estimate the total number of workers exposed to a wide range of specific hazards and the number exposed at varying qualitative levels of exposure;
- Describe the distribution of hazards with regard to occupation, industry, geography, and worker demographics;
- Describe the nature and extent of hazard controls for reducing worker exposure;
- Describe the nature and extent of specific occupational safety and health program components;
- Identify previously unrecognized groups at risk from known hazards; and
- Identify new and emerging hazards (by comparing data from previous surveys and future surveys).

Survey Design

A national, cross-sectional survey of establishments and workers would be conducted utilizing a stratified, multistage sampling strategy to obtain nationally representative data on work place agents to which workers are potentially exposed. The sampling frame would include all industry sectors covered by OSHA and MSHA regulations. Sample selection would be at the four digit Standard Industrial Classification (SIC) level for all of these industry sectors. Sample selection would be stratified by size of facility (i.e., number of employees). This approach would accommodate the need for representative data on small establishments, including those that meet the Small Business Administration definitions of small businesses and establishments of fewer than 10 employees. In order to ensure with 95 percent confidence that estimates of the number of workers exposed to workplace hazardous agents would be $\pm 15\%$ of the actual value, it is estimated that a sample size of between 6000 and 8000 establishments would be required. This sample size would result in a degree of variability for employee estimates (i.e., coefficient of variation) of 20 to 25 percent, which is consistent with the previous surveys.⁽¹⁻³⁾

Data collection would occur on an ongoing basis and cycle through all covered industries within a defined time period (i.e., five years). Comprehensive national estimates from all covered industries, and national and industry-specific estimates would remain current within this time frame. This survey would be repeated once a decade so that data remains adequately current and trends can be evaluated. This frequency should also meet the needs of most potential users.

An on-site survey would consist of three components: (1) a management interview using a standardized questionnaire; (2) a facility observational walk-through by trained surveyors; and

(3) an interview of workers using a standardized questionnaire to obtain perspectives on selected health and safety issues posed to management. A description of the data expected to be collected within each of these components is provided below.

Content

In considering survey content, an approach was followed to be as comprehensive as possible relative to the types of information that would be useful. Although an overly ambitious approach, it is nonetheless necessary at this early planning stage to be as inclusive as possible, with the realization that some hard decisions on content issues would need to be made and a process developed to make these decisions.

The management questionnaire would contain a core set of questions used in the management questionnaire from previous surveys to enable trend analysis. In addition, management and worker survey questionnaires would contain a set of questions tailored to specific industry sectors (health care, manufacturing, mining, construction, agriculture, etc.) to obtain information unique to the particular industry sector.

Management interview. Key management personnel (plant manager, health and safety officer, human resources manager, etc.) at each establishment included in the survey would be interviewed to obtain administrative data, policies, and practices relative to in-plant occupational safety and health programs and overall management perspectives on selected health and safety issues. Data would be collected on the following:

- *Industry summary*—description of the principal line of business and the primary SIC and North American Industrial Classification System (NAICS) codes of the establishment.
- *Demographics*—summary information on gender, race, ethnicity, age, occupation, and functional assignment of workers.
- *Health and safety program components*—information to establish a profile addressing occupational safety and health personnel resources; key program components such as management commitment and employee participation, hazard identification and assessment, hazard prevention and control, information and training; industrial hygiene and safety services; medical surveillance and provision of health care services; ergonomics programs; workplace violence programs; smoking policy; employee assistance programs; and safety incentives. Data would also be collected on administrative safety and health strategies that may be unobservable during the site survey (e.g., personal protective equipment and clothing practices, job rotation).
- *Contingent workers*—information on use of contractors, subcontractors, temporary agency personnel, direct temporary personnel, and so on, and the distribution of these contingent workers at the workplace.
- *Organization of work*—information on work shifts, overtime practices, management strategies (e.g.,

just-in-time processes, work teams), recent organizational changes (reorganizations, downsizing, employment growth), and unionization of workforce.

- *Health and employment outcomes*—summary information for the past three years on injuries, illnesses, turnover, and absenteeism.

Facility observational walk-through. A site survey would be conducted by trained safety and health professionals who would identify and qualitatively (and to a lesser extent quantitatively) assess workplace contaminants to which workers are potentially exposed, and for each identified agent, the exposure durations and controls. This information may be used to set priorities for conducting followup surveys, if more detailed information is needed. The following hazards/workplace factors would be included in the facility survey:

- *Chemical Agents*—chemical agents to be assessed would include vapors, mists, aerosols, gases, particulates and fibers which would be identified by CAS number or other hazard coding systems. The following descriptive information under consideration include the following:

- Exposure level (low, moderate, high)
- Frequency of exposure (incidental, intermittent, routine)
- Duration of exposure (time/shift)
- Route(s) of exposure (dermal, respiratory, ingestion)
- Volume/quantity used
- Proximity of substance to worker
- Process methods/use of substance
- Presence of engineering and/or administrative controls
- Use of personal protective equipment
- Administrative controls
- Work practices

- *Physical Agents*—physical agents and related hazards to be assessed include electromagnetic radiation (radio frequency, ultraviolet radiation, etc.), noise, vibration, temperature, and pressure and heat. Surveyors would obtain qualitative information to characterize potential exposures, commensurate to information listed above for chemicals. Quantitative information would be obtained for certain agents during the observational survey depending on resources.

- *Biological Agents*—biological agents to be assessed may include: viral, bacterial, rickettsial, fungal, parasitic organisms, and components of biological systems (i.e., blood, urine, sputum, feces). Surveyors would obtain qualitative information to characterize potential exposures, commensurate to information listed above for chemicals.

- *Ergonomic Factors*—a limited, standardized ergonomic assessment would be developed to characterize chronic trauma hazards and control strategies for tasks involving manual material handling/physical loads, passive postures, lifting postures, awkward postures, arm transport movements, shoulder transport movements, hand/wrist manipulations, finger manipulations, machine paced work, equipment monitoring, light/glare level, diminished light, and combinations thereof.
- *Safety Factors*—a limited, standardized safety assessment tool would be developed to enumerate and characterize a wide variety of safety hazards including, but not limited to, motor vehicle use, vehicular traffic, violence, machinery and tools, confined spaces, and hazards for explosions, falls, electrocutions, burns, and drownings.

Worker interview. A sample of workers from each work site would be solicited to participate in an interview survey, which would be conducted on-site or off-site by telephone or mail survey. An alternative approach would be to select one or more workers to complete a questionnaire at each establishment; workers may include union representatives or other workers targeted by seniority, occupation, or other factors. Data would be collected on worker knowledge of potential occupational hazards, safety and health programs, and on the organization of work. This information would supplement and be compared to data obtained through the management interviews and site walk-through observations. The worker interviews would be the primary source of information on work organization, non-routine work activities, and unusual events.

National Telephone Survey of Establishments and Workers

A national telephone survey of management and workers is the other option for a broad-based national survey. This option essentially omits any observational data. When comparing to the national on-site survey, this option trades off greater industry specificity (more worksites would be sampled), statistical accuracy, or cost savings against lower data validity, detail, and completeness. This survey option would produce national estimates; however, the richness, quality, and scope of hazard information would be reduced. Furthermore, due to a potentially high non-completion rate for telephone surveys, survey results may not be representative. This trade-off along with the fact that OSHA may soon be initiating a national safety and health practices (telephone) survey⁽⁹⁾ of approximately 4500 establishments covered by the OSHA Act (except agriculture), compelled the Hazard Surveillance Team to recommend this option as a low priority for the Institute.

Targeted Surveys of Establishments and Workers

Surveys targeted to a subset of recognized, high-priority hazards or industries may serve as a less costly alternative to a broad-based national on-site survey or may supplement a

national survey. This approach could include independent surveys and analyses of existing data to obtain in-depth information needed to meet specific policy and research needs. As a supplement (ideally) or alternative to a broad-based national on-site survey, hazard surveys would be targeted based on policy and research priorities and available resources. Targeted surveys may be justified as supplements to obtain quantitative and detailed exposure information (via personal monitoring and review of facility exposure monitoring data), or greater specificity by industry, occupation, process, or geography. This approach would include independent surveys and analyses of existing data to obtain in-depth information needed to meet specific policy and research needs of the Institute.

The specific goals of each survey would vary, but by using a core set of data collection tools, some common goals would be attainable. Targeted surveys would address most of the goals of a national, broad-based survey but would only do so for specified industries or hazards.

Using a targeted survey approach offers research opportunities above and beyond a broad survey approach. Targeted surveys will permit:

- Extensive qualitative and quantitative exposure information on hazards and industries;
- Detailed information on exposure for specific industries and hazards; and
- Detailed information on controls, their costs and perceived effectiveness.

A critical element of a targeted survey initiative would be the process by which targets are established. Survey selection would utilize input from a wide range of federal and state partners, professional groups, industry and labor representatives, and academic leaders, including the opportunity for broad public input. This would help ensure relevant policy and research

needs are considered, and a sufficiently inclusive set of informed perspectives is polled. Some decision criteria that would be considered in the selection of targets include:

- extent to which additional information is needed to directly support activities such as developing standards or policy and establishing research priorities;
- existence of a possible new and emerging problem about which little is known;
- number of affected workers;
- severity of potential health effects; and
- feasibility of implementing effective control measures.

Summary Comparison of Survey Options

A comparison of the advantages and disadvantages and relative costs of each hazard survey option is provided in Table I. Of the three options, the Hazard Surveillance Team feels that a comprehensive, national on-site survey is the optimal data gathering approach. As the lead agency responsible for conducting surveillance of the health and safety conditions of the nation's workers, NIOSH has the unique authority and expertise to conduct a national on-site survey. While such a survey is the most costly to complete, the data would provide the most comprehensive national picture of workplace hazards, and would best meet the needs of NIOSH and key federal partners. On an as needed basis, NIOSH could also supplement the comprehensive national survey with targeted surveys to obtain more comprehensive surveillance data.

Survey Database Considerations

Previous NIOSH hazard surveys may have been underutilized due to difficulty accessing data, access restrictions, long elapsed time between data collection and publication of analyses, and limited promotion. Current technology provides web-based data management systems which will allow policymakers,

TABLE I
Survey options: advantages, disadvantages, and relative costs

Option	Comments	Relative cost
National on-site survey	- Provides the most comprehensive picture of workplace hazards and practices - Provides national estimates of potential exposure by industry and occupation - Best for setting regulatory, policy, and research priorities - Best for meeting needs of federal partners - Best complements past NIOSH hazard surveys allowing for trend analysis - Best for discovery (e.g., new hazards, unrecognized groups at risk) - Requires extensive methods development for some hazards	High
National phone survey	- Sacrifices richness and scope of hazard data - Very similar to OSHA's proposed national safety and health practices survey - Could be completed in relatively short time frame - Low priority	Low
Targeted surveys	- Best for obtaining quantitative data (e.g., levels of exposure, effectiveness and cost of controls) - Best for answering very specific questions	Medium

researchers, and others within NIOSH and among the public to download data files, analyses, and publications, and obtain assistance expeditiously with minimal resources. Such a web-based resource would permit "one-stop-shopping" for a wide variety of potential hazard surveillance data sources and analyses, including linkages to potentially useful databases maintained by other agencies.

A central feature of the proposed hazard survey is web-based access to non-confidential data and related information to promote the use of NIOSH data by the occupational health and safety community as well as the public. A web site for surveillance data would be instituted and provide users with the following:

- Access to non-confidential data from NIOSH surveys and evaluations and relevant documentation and software (e.g., sampling strategy and limitations, questionnaires, statistical analysis software);
- Notification of future availability of survey enhancements;
- Access to a developmental national occupational exposure database including quantitative measurements of exposures to workplace agents obtained from NIOSH activities;
- Links to other relevant web-based surveys and databases;
- Identification of additional surveys and databases for which linked analyses are feasible;
- Reports and news releases on hazard surveillance analyses supported by NIOSH;
- Bibliography of all completed and published analyses conducted using this hazard survey;
- Registration option for automatic e-mail notification of updates to the database and other web-based services; and
- Contact information for technical assistance.

Controlled access of survey data would be provided to extramural researchers in order to support analyses relying on access to potentially identifiable confidential business information and personal data. Security measures would be consistent with CDC and Institute guidelines. NIOSH also plans to coordinate with other agencies to facilitate extramural research relying on linkage of data elements from separate databases.

Routine descriptive analyses of the survey data would be provided. These analyses would be limited by data that is extractable from existing data sources and new data that is collected. All targeted evaluations would have specific reports released soon after the work is completed but the data from these efforts would also go into a larger database (i.e., an occupational exposure database). Data from this database in addition to the data extracted from existing data sources would be summarized on a periodic basis (annually). These could include summary statistics on the distribution, magnitude, and trends of potential

exposure to hazardous agents and risks (chemicals, physical agents, biological agents, ergonomic risks, safety risks, and risk factors deriving from the organization of work). Newly identified hazardous agents/risks and potential agents, occupations or industries for targeted evaluation would also be identified.

Appropriate coding schemes would be used to facilitate the greatest possible opportunities for analyses linking data from the hazard survey with those of other surveys and data sources. Such analyses may be valuable to associate health, economic, and other outcomes with hazard exposures; to enrich available data and increase the inferential value of individual data sources; and to support quality assurance analyses of the NIOSH surveys.

Occupational Exposure Database

Targeted and, to a lesser extent, broad-based hazard surveys would represent a valuable source of quantitative occupational exposure data on chemical, physical and biological agents. With the appropriate descriptive information on industry, occupational title, routes of exposure, use of controls, and so on, information from the proposed hazard survey could be incorporated in an occupational exposure database. Survey exposure data initially would be merged with exposure data from other NIOSH field activities including, but not limited to, health hazard evaluations, control technology assessments, industry-wide and mining surveys. With the support of other agencies and stakeholders, this database would be expanded to include exposure data from federal and state agencies, academia, and the private sector. A national occupational exposure database would be an indispensable exposure surveillance tool as it would provide policymakers and researchers a uniquely extensive and searchable source of quantitative information for characterizing occupational exposures to recognized and regulated hazards.

CONCLUSION

NIOSH is planning a new hazard survey which will serve to update information on the distribution of health and safety hazards and exposures in industries regulated by the OSHA and the MSHA. Three options for such a survey have been presented herein; the recommendation of the Hazard Surveillance Team is to conduct a broad-based, national on-site survey analogous to the previous NIOSH hazard surveys. While such a survey is the most costly to complete, the data from it would provide the most comprehensive picture of workplace hazards and controls while meeting the needs of NIOSH and key federal partners. The proposed new hazard survey builds on lessons learned from the previous surveys, seeks opportunities to incorporate existing data from other sources, expands the scope of industries and hazards, and takes advantage of advances in data gathering, processing, and dissemination technology. Quantitative exposure data from a hazard survey and other NIOSH field activities would provide a valuable source of information for a national occupational exposure database.

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