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Conducting Worksite Investigations

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Most workplaces in the United States do not have on-site occupational safety and health specialists, and the United States has not signed on to several International Labour Organization conventions requiring them. Employment of occupational health and safety specialists in the United States is projected to grow only 4% from now until 2024, slower than the average for all occupations.[1] Therefore, many workplaces will lack specialists capable of conducting onsite workplace investigations.

Proactive workplace investigations can generate knowledge, implement preventive interventions, and offer control of hazardous exposures. Despite best-practice recommendations by safety and health organizations, investigations at worksites generally are not done proactively. They are usually performed to fulfill legal requirements, to determine costs of injuries or illnesses after the fact, to determine compliance with applicable safety regulations, or to address specific workers' compensation claims. Occupational health and safety specialists are rarely consulted to conduct investigations because of new workplace processes/technologies or other newly introduced changes, at which time they would have the opportunity to identify the need for any new preventive measures.

Employees in small businesses have much higher fatal and nonfatal traumatic injury rates compared to larger worksites, but small businesses are least likely to have onsite safety and health capabilities. The Occupational Safety and Health Administration (OSHA) provides funding for no-cost worksite investigations through its On-Site Consultation Program for small businesses, which offers industrial hygiene and safety evaluations unrelated to enforcement (see https://www.osha.gov/dcsp/smallbusiness/consult.html for further information). These services are able to identify known hazards and provide recommendations based on existing standards. When new hazards or new health outcomes occur, or require new approaches to prevention, the National Institute for Occupational Safety and Health (NIOSH) Health Hazard Evaluation program offers an approach that offers assistance to the affected workers and worksites as well as generalizable new information for others.

This chapter describes the general principles of conducting workplace investigations, recognizing potential hazards, preparing for on-site

investigations, conducting these investigations, making useful and practical recommendations, and proactively intervening to implement them. After identifying hazards, exposures, or working conditions, the goal is to control or reduce them to acceptable risk levels—or eliminate them entirely—and then to ensure that periodic reevaluations are done as part of routine operations. Cases 1 through 4 at the end of this chapter describe four worksite investigations that the NIOSH Health Hazard Evaluation Program has performed, illustrating the elements of this approach.

IMPORTANCE OF WORKSITE OBSERVATION

There is no substitute for being on-site and witnessing work processes and tasks in "real time." Direct observation leads to a better understanding of exposures and working conditions, and it assists in developing better strategies for intervention. It helps with formulating recommendations on (a) the occupational health and safety hierarchy of controls, such as eliminating a hazardous substance or substituting a less hazardous one; (b) specific engineering controls, such as local ventilation; and (c) administrative controls. It also enables a health and safety specialist to recognize hazards or unsafe conditions that may go unnoticed by workers or employers.

Evaluating a workplace often requires a multidisciplinary approach. Input by employees and employers, physicians, engineers, chemists, health physicists, and social scientists may be needed to successfully address hazards and unsafe work conditions. The most successful approaches coordinate many disciplines and incorporate effective communication between employees and employers for recognizing, evaluating, and controlling hazards and unsafe working conditions. A multidisciplinary approach may not be practical for many workplace situations. However, each person evaluating a workplace must be knowledgeable of possible contributions of other professionals in solving problems. For example, a physician studying a work environment should have not only knowledge of the health effects of specific chemical exposures but also a basic understanding of the relevant chemistry, chemical-sampling techniques, and engineering requirements for control.

To recognize potential hazards at a workplace, one should become familiar with work processes, review a list of possible hazardous exposures, consider job activities and job conditions in work areas of interest, and determine possible control options for exposures or hazards that may be present. One also needs to determine how managers and direct supervisors respond to workers' reports of health concerns. Supervisors' or managers' responses to these reports and investigations of potential causative factors provide clues on how they approach workplace problems and how committed they are to prevention.

THE NIOSH HEALTH HAZARD EVALUATION PROGRAM

The NIOSH Health Hazard Evaluation (HHE) Program responds to requests for workplace evaluations from employees, unions, employers, and other governmental agencies. A *health hazard evaluation* is an investigation of a workplace to assess whether workers are exposed to hazards or harmful conditions. The NIOSH HHE program, using teams of various occupational health experts, including epidemiologists, industrial hygienists, occupational health specialists (physicians, nurses, and veterinarians), and psychologists, conducts about 250 investigations annually. Through this program, NIOSH identifies hazards and recommends practical, scientifically valid solutions for reducing exposures, controlling harmful conditions, and preventing disease, injury, and disability.

Preparing for a Workplace Investigation

Gathering Information

Investigators develop overall plans, collaboratively determine specific questions to be answered, and plan the investigative strategy. Initial telephone calls obtain information about workplace problems with those who requested the investigation, workers, managers, and other people. Initial information is obtained on

workplace operations, the materials or chemicals used, hazards present, processes and work tasks, time sequence and duration of existing problems or concerns, previous actions taken to address the problems, recent process or materials changes, and the urgency of the situation. According to OSHA, emergency situations are those that are immediately hazardous. Investigators determine who might be aware of the potentially work-related health problem at the workplace. If there is a labor union that represents workers who may be affected or exposed, it is informed about the investigation and a representative is asked pertinent questions, including about whether the union has any additional relevant information and if the union provides any medical surveillance, special medical testing, or recordkeeping on its members.

At the time of the initial telephone call, determination is made about the parties who need to be included in the investigation: employers, workers, any worker representatives (from local and national unions), medical care providers, other health professionals, and local and state health department representatives. Critical to a successful investigation is involvement from the start of employees and their representatives, such as union stewards, as well as managers and other employer representatives.

Because employees have a unique understanding of job tasks and working conditions, information gained from them is especially valuable in determining whether hazards exist and assessing them. Involving employees from the start helps to improve the quality of the investigation, minimize oversights, and enable them to fully understand the need for the investigation and gain their cooperation.

Usually, with some background investigation, early clues help determine the scope of necessary work. For example, illness among many workers in different jobs in various departments likely indicates the need for a full-scale, workplace-wide investigation. Alternately, if suspected problems are confined to isolated tasks or relatively few workers, only a more limited, focused investigation may be necessary.

During the first encounter (by phone, e-mail, web-based conferencing, or a face-to-face meeting), one needs to determine what health and safety hazards might be encountered onsite and what personal protective equipment (PPE) members of the investigative team might need during the initial investigation to the site. If respirators are required on-site, only personnel who have been medically cleared, trained, and fit-tested can use them.

Roles of the Investigative Team

For the industrial hygienist, preparation for a field investigation begins with identifying exposures of concern, determining whether there are appropriate sampling and analytical procedures that will need to be performed, determining analytical chemistry or microbiological services needed, determining proper instruments to be selected, and making an industrial hygiene equipment list. Determining appropriate sampling usually requires being on-site or having enough information beforehand to know exactly what needs to be sampled, where, and why; performing sampling in a rush and obtaining unneeded data points (because "it may be the only opportunity to sample") is rarely fruitful. Preparation for sampling includes arranging for equipment, supplies, and analytical services and knowing any shipment requirements for hazardous materials. It also requires preparing consent and notification forms for personal sampling.

For the occupational medicine physician, preparation involves searching the medical literature, reviewing medical records, and having the diagnostic and examination skills to sort out what may be work related in the workplace. Medical support staff responsibilities may include designing a study; developing the investigative protocol; obtaining necessary approval from an institutional review board; preparing consent forms, notification forms, questionnaires, and other data-collection forms; and arranging for field-study materials, personnel, and medical tests.

If biological testing is to be conducted, arrangements need to be made for clerical support, data-collection forms, supplies for venipuncture and collection of urine or other biological samples, as well as forms to request tests not routinely performed by clinical laboratories, such as those for metals, pesticides, volatile organic compounds, polychlorinated biphenyls, furans, dioxins, polycyclic aromatic hydrocarbons, phthalates, and flame-retardants. Plans also need to be made

for special studies, such as pulmonary function tests, chest X-rays, neurological and neuropsychological tests, or other examinations that may require a consultant.

Obtaining Needed Information Before the Site Visit

Team members need to be informed about the worksite—exposures, products, and personnel with whom they will be interacting on-site. Many manufacturers have technical and other information on their websites on product lines, work processes, financial status, and managerial systems. Major unions also have useful information on their websites. Information on websites also includes research findings, technical experts, and survey instruments.

If the worksite is a manufacturing facility, investigators need to learn about goods produced, chemicals and other substances used, and intermediate products formed in the production processes. Much of this information can be obtained before the site visit through discussions with employees, employers, and technical experts or from the Internet.

Before the site visit, it is useful to obtain worksite records on exposure monitoring, purchasing, production, health and safety policies, and operating procedures, all of which can help in determining the exposures of greatest concern. Employee rosters, staffing lists, employee turnover rates, and floor plans may also provide useful information. Reviewing these documents prior to the site visit will help give investigators a better understanding of potential hazardous exposures and company procedures to respond to hazardous situations. The site visit will help to determine whether these procedures are actually operational or are only "on paper" and not performed.

Safety data sheets (SDSs) on hazardous substances, which are mandated at manufacturing plants by the OSHA Hazard Communication Standard, are useful documents to obtain from management. Workplaces in certain industries may not have SDSs; however, containers of hazardous substances that they use, such as cleaning products and insecticides, are required to have hazard warning labels that can provide some toxicity information.

OSHA Logs and Other Existing Records

Investigators can request to obtain (a) the logs of injuries and illnesses that are required by OSHA (OSHA's Form 300; Log of Work-Related Injuries and Illnesses) and (b) worksite medical records, workers' compensation claims, insurance claims, absentee records, and job-transfer applications, all of which can yield useful information on work-related injuries and illnesses. If workers in certain departments or processes have higher rates of health problems than others, especially if they have the same type of injuries or illnesses, this suggests specific areas for investigation. Jobs with increased rates of certain symptoms, such as lightheadedness or concentration problems, may also have higher risks for acute injuries.

The Occupational Safety and Health Administration mandates that each worksite it covers allows access to illness and injury log summaries; OSHA also has a new provision that mandates that employers electronically submit injury and illness data, in addition to keeping the same records on-site. Certain data must be posted to the OSHA website, which can provide valuable information for (a) other worksites with similar processes, (b) investigations of a specific worksite, and (c) comparison of rates within an industry. The Occupational Safety and Health Administration also still requires the posting of annual average number of employees and total hours worked during the calendar year, so that workplace injury and illness incidence rates can be calculated. Companies with no recordable injuries or illnesses must still post the form. All summaries must be certified by a company executive. Employers are also required to make a copy of the summary available to employees who move from worksite to worksite, such as construction workers, and employees who do not regularly report to any specific worksite.

Medical and First-Aid Records

Investigations of suspected work-related injuries and illnesses should also include review of first-aid and medical records to understand the magnitude and seriousness of such problems. The Health Insurance Portability and Accountability Act (HIPAA) requires that (a) specific medical-release authorization from individual workers be given before access to

their medical records can be obtained and (b) employers and on-site healthcare providers protect individual health data. Public health officials are exempt from HIPAA requirements and are authorized by law to have access to individual health information for the purpose of preventing or controlling disease, injury, or disability—including for investigations and interventions. Examination of employee first-aid and medical records may offer clues to jobs or operations that may cause or contribute to other work-related problems. Review of electronic health data from first-aid stations or medical clinics at a worksite (without identifying information) may help identify trends or clusters of injuries or illnesses.

Performing a Worksite Investigation

The Initial Worksite Visit

The primary purposes of the worksite visit are to (a) determine, while on-site, the extent and severity of the problem; (b) identify possible causes; (c) determine if, at an early stage of the investigation, there may be possible solutions to the problem; and (d) ascertain whether further assessment is needed. An initial site visit can be usually completed in 1 or 2 days, but it may take longer if more time is needed to complete it without a follow-up visit.

A good way to start the site visit is with a meeting with all those involved, including the facility manager, the chief local union official (or other worker representative if employees are not represented by a union), healthcare professionals, engineering and maintenance workers familiar with the facilities, and consultants who are familiar with the facility. Employees from the area of concern must attend meetings. It is important to discuss plans for (a) assuring confidentiality of information from worker interviews and personnel and medical records and procedures for videotaping, photographing, and other recording and (b) sharing summary data (without personal identifying information) with all parties. Personal protective equipment requirements and any other relevant safety procedures to be used during the investigation should be reviewed.

Walkthrough Observational Survey

A walkthrough survey, which can be the most important part of the investigation, should include managers, employees, and their representatives, including the person who requested the workplace investigation, unless that person has requested confidentiality or has declined to participate (Figure 33-1). Usually, the main purposes of the walkthrough survey are to observe the facility in routine operation, to view worker activities, to identify any potential hazards, and to talk

Figure 33-1. An industrial hygienist and an occupational medicine physician pause for questions from a worker during a workplace walkthrough survey. (Courtesy of the National Institute for Occupational Safety and Health.)

informally to employees, managers, and others about perceived exposure and health problems.

The walkthrough allows observation of workers performing job tasks, use of PPE or protective clothing, placement of materials, tools, physical layout of the workplace, and the organizational climate. Many potentially hazardous operations can be detected by observation during the walkthrough. Using lists obtained beforehand of chemicals, raw materials, products, and by-products assists in identifying hazardous inhalational and skin exposures. Knowledge of fuels used in burning processes assists in identifying air contaminants. Observation of ventilation systems helps to determine needs for improved control measures. The walkthrough can assist in understanding job tasks that place workers in specific jobs at risk and can help determine the need for additional industrial hygiene sampling, worker interviews, and medical testing.

The dirtiest, dustiest operations are not necessarily the most hazardous. For example, dust particles that cannot be seen by the unaided eye can be the most hazardous because they are of respirable size. The absence of a visible dust cloud does not necessarily mean that there is no airborne dust. Odors are not reliable indicators of exposure: odors one might not detect of vapors and gases present in concentrations considerably above their permissible levels, and one's ability to detect an odor often decreases as exposure continues.

Workers' Job Tasks

It is important to obtain a list of workers' routine job tasks and requirements in areas of the workplace being investigated. Changes in job requirements or modifications of work techniques or processes may have profoundly affected hazardous exposures. Shift work or overtime work requirements may contribute to prolonged exposure of workers, which may not occur on an 8-hour work schedule.

Most job tasks can be described in terms of (a) tools, equipment, and materials used; (b) workstation layout and physical environment; (c) task demands; and (d) organizational climate in which the work is performed. More definitive procedures for collecting information on job tasks can include the following:

- Videotaping to observe workers performing tasks for a time-activity analysis
- Photographing workstation layout, tools, materials, and chemicals used
- Recording workstation measurements and characteristics of work surfaces, including heights, edges, reach distances, and slip resistance
- Determining perceived exertion of workers.

While screening tools, such as checklists, have been widely used in many investigations, most have not been scientifically validated. Combining checklist observations with data on symptoms offers a way of reducing uncertainty.

Focusing on Jobs

Jobs associated with the most, or the highest rates of, occupational illnesses and injuries deserve the most attention. Jobs in which recent cases have occurred deserve priority attention. Priority for job analysis and intervention should be given to those jobs in which (a) the most people are affected or (b) changes in work exposures or processes are taking place or planned. Jobs associated with workers' complaints of fatigue and discomfort should be ranked next in priority for analysis and intervention. Finally, where screening suggests presence of significant risk factors or exposures for occupational illnesses or injuries, more-detailed job analyses should be done. Jobs with higher levels of exposure or multiple risk factors may indicate a need for control.

Selection of Instruments to Evaluate the Work Environment

Industrial hygiene sampling (Figure 33-2) is sometimes necessary on the initial site visit to determine the range of exposures to begin planning for more definitive sampling (Chapter 8). Direct reading instruments and/or detector tubes are generally used because of their portability and ease of use. In-depth quantitative air sampling is generally not done on the initial site visit.

Interviews

The lead investigator should establish a schedule to interview the following people:

- Managers and other employer representatives
- Workers (Although it is reasonable to interview specific workers at their request or the

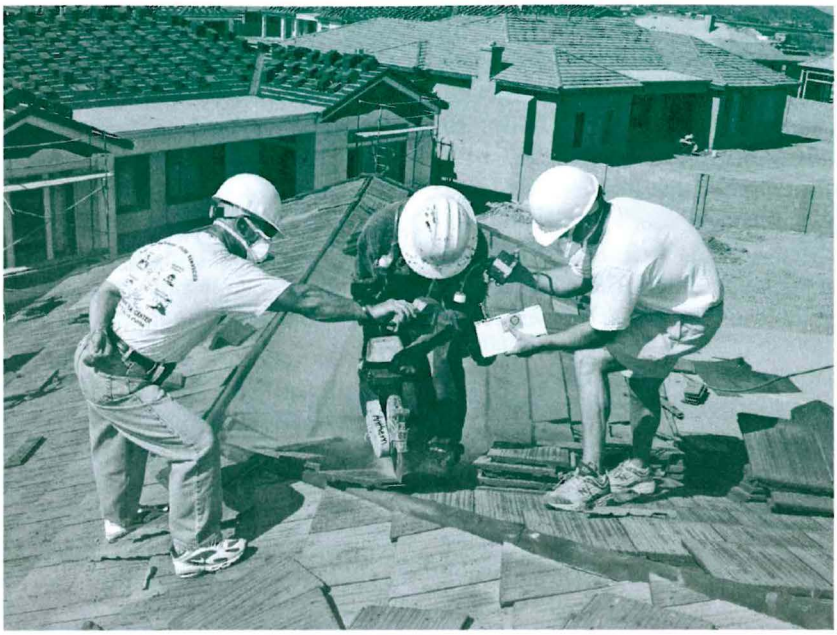

Figure 33-2. Industrial hygienists collect follow-up samples for a silica exposure among roofers. (Courtesy of the National Institute for Occupational Safety and Health.)

request of others, it is important to interview a cross-section of workers. Group interviews can supplement individual interviews, recognizing group dynamics may provide different perspectives than individual interviews.)
- Union representatives
- Physicians, nurses, and other health and safety personnel
- Representatives of the human resources department.

Conducting Symptom Surveys

Symptoms surveys may assist in focusing on specific concerns of workers and in identifying possible work-related disorders that might otherwise go unrecognized. These surveys provide information to narrow the focus of investigation. In addition to questions about workers' job titles, work history, job tasks, and past and present medical history, the location, frequency, duration, and intensity of symptoms will help to determine the focus of the investigation. By definition, symptom surveys rely on self-reports, a potential limitation. One has to be careful not to overanalyze information obtained from surveys based on small numbers of workers. An epidemiologist can assist with questionnaire design and data analysis. It is important to mention that any personal identifying information generated from surveys will be protected, and confidential information will be accessible only to authorized medical personnel.

Medical Examinations

One disadvantage of using OSHA logs or company-based medical information to identify possible cases of work-related injuries or illnesses is the lack of uniform case definitions. In the NIOSH HHE program, investigations have included limited physical examinations focused on specific organ systems or parts of the body. Information obtained can help establish the prevalence of possible work-related conditions. Using a comparison group of unexposed workers may be helpful in determining a work-related condition based on differences in prevalence. Screening medical examinations, performed periodically at some workplaces may provide valuable clues, but they are generally not designed for continuous surveillance of specific exposures.

Integration of Data

All team members involved in an on-site investigation should have prepared an integrated strategy to answer specific questions prior to data gathering. After the initial meeting with all parties, the observational walkthrough, and data-gathering, the team needs to meet on-site to discuss changes in the strategy and integration of their initial findings. This process will help formulation and planning of the next steps.

Summarizing On-Site Information and Holding a Closing Conference

This involves the following steps:

- Hold a closing conference before the initial worksite visit is completed to discuss what has been accomplished
- Invite those present at the opening conference and other key employees and managers
- New recommendations can be made, and previous ones can be modified
- Future activities and reports can be discussed.

Data Management and Information Security

A computer database is an excellent format with which to manage information and records from a site visit. In order to maintain privacy required by law and to facilitate communication among investigators, issues of information security must be addressed prior to the on-site visit. All records, notes, forms, and other data from the site visit need safeguards to prevent unauthorized access. This means preplanning for records that will be obtained and may involve information technology personnel who can assist with methods for secure transfer of electronic data and records.

Miscellaneous Activities After the Site Visit

Miscellaneous activities include the following:

- Check and decontaminate all equipment used for industrial hygiene monitoring
- Arrange for laboratory analysis of samples
- Review and check analytical results for reliability
- Arrange for coding, entry, analysis, storage, and maintenance of investigation data and records.

Conducting Follow-up Activities

Within a few days of the initial site visit, a letter should be sent to the manager and the employee representative summarizing the findings of the visit. The letter should use plain language and provide a clear understanding of possible health effects associated with the hazards encountered. A conference call with all parties involved can also communicate information on findings from the site visit. For hazards recognized during the site visit and mentioned in the closing conference, written documentation can facilitate timely implementation of control measures. Any results and recommendations reported by phone should be included in a subsequent written report. Preparation of the final report to employers and employees should integrate both the industrial hygiene/environmental and medical/epidemiological components of the investigation.

Considering Recommendations

An employee (labor)-management health and safety committee or working group should discuss the recommendations and develop an action plan. (If employees belong to a labor union, this committee should already exist.) Those involved in the work can best set priorities and assess the feasibility of the recommendations for the specific situation.

The occupational health and safety hierarchy of controls—widely accepted as an intervention strategy for controlling workplace hazards (Chapters 4 and 8)—is useful in outlining recommendations in the report:

- Elimination and substitution
- Engineering controls
- Administrative controls (changes in work practices and management policies)
- Use of PPE

Elimination and Substitution

Eliminating or substituting hazardous processes or materials reduces hazards and protects employees more effectively than other approaches. Eliminating a hazard in design or development of a project reduces the future need for additional controls.

Engineering Controls

Engineering controls reduce employees' exposures by removing the hazard from the process or by placing a barrier between the hazard and the employee. Engineering controls protect employees effectively without placing primary responsibility of implementation on the employee. Questions on existing engineering control strategies at a worksite should include the following:

- If elimination of a hazard is not possible, are work operations isolated or enclosed to reduce worker exposures?
- Are wet methods being used to reduce generation of dusts?
- Is general ventilation adequate?
- Is shielding from radiant heat, ultraviolet light, radiation, and other forms of energy used?
- Are parts on an assembly line presented in a way to ensure proper reach, hold, and use by the worker?
- Is equipment height-adjustable, are tools in adequate proximity to workers, and are objects handled of appropriate weight?

Administrative Controls

Administrative controls refer to employer-dictated work practices and policies to reduce or prevent hazardous exposures. Their effectiveness depends on both employer commitment and employee acceptance. Regular monitoring and reinforcement are necessary to ensure that policies and procedures are followed consistently. Administrative control recommendations can address issues such as the following:

1. Scheduling shifts and rest breaks
2. Rotating workers in and out of specific jobs
3. Evaluating production quotas and performance standards concerning their impact on workplace stress, work pace, and worker control
4. Providing meaningful light-duty jobs, as deemed appropriate, to allow injured or ill workers to maintain contact with fellow employees and gradual return to normal activities, while providing for specific medical needs
5. Providing periodic training of employees on work risk factors and recordkeeping
6. Implementing medical management and surveillance programs
7. Implementing workplace policies to prohibit smoking
8. Implementing appropriate procedures for housekeeping, waste disposal, eating and washing, and use of restrooms.

Many administrative recommendations should be seen as (a) temporary measures until engineering controls can be implemented or (b) measures to use when engineering controls are not technically feasible. Since administrative controls do not eliminate hazards, managers must ensure that practices and policies are diligently followed. Administrative controls are "stop-gap" measures—not permanent solutions.

Personal Protective Equipment

Personal protective equipment is the least effective means for controlling hazardous exposures. Proper use of PPE requires a comprehensive program and a high level of employee involvement and commitment. Appropriate PPE must be chosen for each hazard. Supporting programs and procedures, such as training, schedules for the changing of respirator cartridges, and medical assessment, may be needed. Personal protective equipment should not be the sole method for controlling hazardous exposures. PPE should be used only until effective engineering and administrative controls have been implemented.

Implementing and Evaluating Controls

Implementing controls normally consists of (a) initial testing of the selected measures, (b) modifying these measures based on initial testing, (c) implementing them on a large scale, and (d) evaluating their effectiveness. By testing and evaluating measures, one can determine whether they achieve the desired outcome and identify any necessary modifications. Workers can provide valuable input into testing and evaluation. Worker acceptance of changes is important to the success of the control measures. Workplace control measures often start by targeting problems clearly identified in the workplace investigation and those problems that appear easiest

to solve. Early success can build confidence and experience needed later to solve more complex problems.

Implemented controls should be periodically evaluated to determine whether they have reduced hazards and/or decreased injuries or illnesses and to ensure that control measures have not introduced new risk factors. Follow-up evaluation should occur no sooner than 6 weeks after implementation of control measures to avoid discarding effective control measures that may not have yet demonstrated their benefits. Evaluation may also include a symptom survey, completion of a risk-factor checklist, and/or another job-analysis method. Results of a follow-up symptom survey can be compared with those of the initial symptom survey to determine the effectiveness of control measures in reducing symptoms. (One should be aware that some ergonomic control measures lead to changes in work methods, requiring workers to use different muscle groups, which may make them sore during the "break-in" period.)

PROACTIVE APPROACHES

To this point, the topics outlined in this chapter have represented *reactive* approaches for workplace investigations. In contrast, *proactive* approaches are geared to preventing problems from developing. Proactive measures emphasize designing work tasks and processes to avoid causes of occupational illnesses and injuries. They include design of operations that ensure proper selection and use of tools, job tasks and processes, workstation layouts, and materials that are unlikely to harm workers.

Ideally, workplace problems are identified and resolved in the planning process. In addition, general occupational health and safety knowledge, learned from an ongoing health and safety program, can be used to build an approach more oriented to prevention. Management commitment and employee involvement in planning are essential. For example, management can set policy to require health and safety considerations for any equipment to be purchased, and production employees can offer ideas on the basis of their experiences for alleviating potential problems.

Decision-makers who are planning new work processes, especially those involved in the design of job tasks, equipment, and workplace layout, must become more aware of health and safety factors and principles. Designers must have appropriate information and guidelines about risk factors for occupational illnesses and injuries and ways to control them. Studying past job designs can help determine what improvements are needed. (See Chapter 9.)

Because design strategies try to target the causes of potential occupational illnesses and injuries, engineering approaches are preferred over administrative approaches. They eliminate risk factors instead of only reducing exposure to them.

WORKSITE INVESTIGATIONS

Heat Stress Among Firefighters

Firefighters are exposed to heat from several sources, including heat generated by fire, ambient temperatures, physical exertion, and firefighting "turnout" gear. The weight of the turnout gear and firefighting equipment increases physical exertion and, in turn, increases overall heat load. Heat exposure can result in heat-related illness (Chapter 12C). The combination of heat accumulation and overexertion can also result in rhabdomyolysis, with breakdown of muscle tissue resulting in potentially fatal effects on the heart and kidneys.

NIOSH conducted a site visit in response to a request from a fire department to evaluate the risk of heat-related illness and rhabdomyolysis among firefighter cadets and instructors during training. Investigators conducted a 4-day investigation during a 10-week training course. Thirty-two firefighters completed questionnaires on work history, medical history, hydration, and symptoms of heat-related illness and rhabdomyolysis. Investigators tested for levels of creatine kinase (a marker of muscle damage). They monitored participants for signs of dehydration during and after the 8th week of the training course, measured their body weight before and after each training day, and monitored their work activities and fluid intake. They also determined ambient wet bulb globe temperature each day.

One participant had rhabdomyolysis and 16 others had elevated creatine kinase levels. Most firefighters met criteria for excessive heat strain at some point during the week. Environmental conditions often exceeded heat stress limits.

Recommendations were made to schedule training sessions during cooler parts of the day and year; include specific training and educational materials about the signs, symptoms, and risk of rhabdomyolysis; and instruct firefighters to carry wallet cards (a) to inform healthcare workers of their risk for both heat stress and rhabdomyolysis (an often missed diagnosis); (b) to refrain from taking energy/exercise supplements; and (c) to tell their supervisors immediately if they experienced early symptoms of heat-related illness (dizziness, nausea, rapid heart rate, cramping, or lightheadedness) or rhabdomyolysis (muscle pain or weakness, or abdominal pain) or if they noted these symptoms in other firefighters.

Hazards in Nail Salons

Nail salon employees are potentially exposed to hazardous chemicals, ergonomic hazards, and work organization and job stress factors, including work–family imbalance, nonstandard work arrangements, and long work hours.

The National Institute for Occupational Safety and Health received several HHE requests to evaluate employee exposures at nail salons. A walkthrough evaluation of these salons identified hazardous airborne chemicals and ergonomic risk factors and ways of reducing these problems. Ethyl methacrylate and methyl methacrylate in nail polish can cause contact dermatitis, asthma, and irritation of the eyes and respiratory tract.

Investigators collected general area air samples for total and respirable particulate matter during the application of artificial nails. They measured temperature, relative humidity, and carbon dioxide concentration at various locations in salons. They traced ventilation-system ducts to determine the source of outside air, and they conducted employee interviews. The investigators made recommendations that could be quickly and easily implemented, such as keeping all bottles of fingernail liquid tightly capped, putting soaked gauze pads in sealed bags before being thrown in the trash, changing trash-can liners daily, and pouring only needed amounts of fingernail liquid into dispenser bottles. They advised technicians (a) to wear long sleeves and gloves to protect their skin from acrylic dust; (b) to wash their hands, arms, and face with mild soap and water several times during the day to remove potentially irritating dust; and (c) to avoid eating, drinking, and smoking in work areas where artificial fingernails were applied. They instructed workers that methacrylates in nail dust can be carried accidentally to one's mouth on a cup or other utensil. They recommended posters with information and warnings in appropriate languages. They also recommended adjustable chairs and equipment, instituting rest breaks for workers, and reducing use of tools that require a pinch grip.

Coffee and Diacetyl

Workers at coffee-processing facilities may be at risk for bronchiolitis obliterans, an irreversible lung disease due to exposure to diacetyl or 2,3-pentanedione (both alpha-diketones). These chemicals, which are naturally produced when coffee beans are roasted, are added to flavored coffee. The National Institute for Occupational Safety and Health has been investigating coffee-processing facilities to introduce exposure monitoring and workplace interventions to reduce levels to these chemicals and prevent illness among workers.

The National Institute for Occupational Safety and Health received a confidential HHE request from employees at a coffee-processing facility, who were concerned about severe shortness of breath and eye irritation. The facility roasted green coffee beans. It also produced and packaged flavored and unflavored coffee—both whole beans and ground coffee. Physicians had diagnosed bronchiolitis obliterans in five employees who had worked at this facility. Flavored coffees often contain alpha-diketones, which can cause severe respiratory problems.

The National Institute for Occupational Safety and Health conducted an industrial-hygiene and medical evaluation at the facility. Air concentrations of diacetyl and 2,3-pentanedione were above proposed NIOSH recommended exposure levels. The combined alpha-diketone

exposure during grinding/packaging *unflavored* coffee was comparable to the manufacture and processing of *flavored* coffee. Compared to the general population, workers had a 60% higher prevalence of shortness of breath on exertion and a 170% higher prevalence of obstructive pulmonary disease, based on spirometry. Workers at this facility were at risk of bronchiolitis obliterans. The National Institute for Occupational Safety and Health provided its best-practices document on engineering controls, work practices, and exposure monitoring for diacetyl and 2,3-pentanedione to the employer and workers at the plant.

Recycling of Electronic Materials

A substantial—and increasing—amount of electronic waste (e-waste) is produced daily in the United States. Only about 20% is recycled to recover valuable, but hazardous, materials, including lead, cadmium, other toxic metals, and flame retardants. Recycling workers can be exposed to these materials, as well as to noise and ergonomic hazards. Risk of occupational illness and injury is especially high at facilities that shred electronics and process cathode ray tube glass.

The National Institute for Occupational Safety and Health received a request from a manager at an electronic-scrap (e-scrap) recycling facility, who was concerned about exposures of employees who handled recycled computers, monitors, hard drives, televisions, printers, and light bulbs. Eighty workers sorted, disassembled, and shredded e-scrap, including cathode ray tubes from computer monitors and televisions, using pneumatic pistol-grip tools. Then they sorted metals and glass. The warehouse had no ventilation. Workers in the shred room were required to wear company-provided long-sleeve uniforms, safety glasses, half-mask cartridge respirators, hearing protectors, bump caps (lightweight hard hats), steel-toed safety boots, and cut-resistant gloves and sleeves. Most other employees wore hearing protectors, safety glasses, and steel-toed safety boots.

Before making the site visit, NIOSH investigators obtained and reviewed company health and safety records, noise and airborne-lead exposure records, employee blood lead levels (BLLs), and company respiratory protection, hearing conservation, and hazard communication programs. On-site, they observed workplace conditions, work processes, and practices. They held confidential employee medical interviews, asking about medical history, health issues, job duties, and PPE use. They collected various biological and environmental samples. Although results of biological sampling for all metals were below OSHA standards, two employees had BLLs above 10 μg/dL. Lead and other metals were found on the skin of employees, both at lunch and prior to their leaving the workplace. Metals were also found on nonproduction work surfaces.

The investigators saw good compliance with the use of required PPE but that voluntary-use respirators were used improperly (used with only one strap or used despite facial hair). They noticed several work practices that could result in unnecessary lead exposure, such as workers reusing dirty uniforms, not showering at the end of shifts, laundering workclothes at home, not removing uniforms or gloves upon leaving the shred room, and using compressed air to clean work. Lead and other metals were being tracked outside of the shred room and were found on surfaces in nonproduction areas, on the skin of employees, and on an employee's clothing on leaving the workplace. There was concern about contaminating cars and homes, thereby exposing family members to these metals.

The investigators recommended several engineering controls, such as extending the glass shredding conveyor so that the lead-containing cathode ray tubes would be transported directly to the shredder without breaking them. They suggested providing employees elevated work surfaces to reduce bending and risk of back injury. They recommended providing employees with their BLLs and providing "scrubs" to wear under work uniforms (both to be laundered by a contractor) as well as disposable shoe covers. They also recommended better workplace "housekeeping," no dry sweeping or use of compressed air to clean, improved hand hygiene with lead-removing soap, and preventing employees from taking potentially contaminated PPE from the production areas to nonproduction areas, including the lunchroom.

AUTHOR'S NOTE

The findings and conclusions in this chapter are those of the author and do not necessarily represent the views of the National Institute for Occupational Safety and Health.

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