STEP 5
DEVELOPING CONTROLS

- **Types of Controls**
  - **Engineering Controls**
  - **Administrative Controls**
  - **Personal Equipment—Is It Effective?**
- **Implementing Controls**
- **Evaluating Control Effectiveness**

Analyzing jobs to identify factors associated with risks for WMSDs, as discussed in Step 4, lays the groundwork for developing ways to reduce or eliminate ergonomic risk factors for WMSDs. A variety of approaches can help to control these risk factors.

TYPES OF CONTROLS

A three-tier hierarchy of controls is widely accepted as an intervention strategy for controlling workplace hazards, including ergonomic hazards. The three tiers are as follows:

- Reducing or eliminating potentially hazardous conditions using engineering controls
- Changes in work practices and management policies, sometimes called administrative controls
- Use of personal equipment

Engineering Controls

The preferred approach to prevent and control WMSDs is to design the job—including (1) the workstation layout, (2) selection and use of tools, and (3) work methods—to take account of the capabilities and limitations of the workforce. A good match (meaning that the job demands pose no undue stress and strain to the working population as a whole) helps ensure a safe work situation. On the other hand, the presence of risk factors as described in Step 4 represents departures from this goal and would indicate the need for control measures. Engineering control strategies to reduce ergonomic risk factors include the following:

- Changing the way materials, parts, and products can be transported—for example, using mechanical assist devices to relieve heavy load lifting and carrying tasks or using handles or slotted hand holes in packages requiring manual handling
- Changing the process or product to reduce worker exposures to risk factors; examples include maintaining the fit of plastic molds to reduce the need for manual removal of flashing, or using easy-connect electrical terminals to reduce manual forces
- Modifying containers and parts presentation, such as height-adjustable material bins
- Changing workstation layout, which might include using height-adjustable workbenches or locating tools and materials within short reaching distances

- Changing the way parts, tools, and materials are to be manipulated; examples include using fixtures (clamps, vise-grips, etc.) to hold work pieces to relieve the need for awkward hand and arm positions or suspending tools to reduce weight and allow easier access
- Changing tool designs—for example, pistol handle grips for knives to reduce wrist bending postures required by straight-handle knives or squeeze-grip-actuated screwdrivers to replace finger-trigger-actuated screwdrivers
- Changes in materials and fasteners (for example, lighter-weight packaging materials to reduce lifting loads)
- Changing assembly access and sequence (e.g., removing physical and visual obstructions when assembling components to reduce awkward postures or static exertions)

Figure 2 applies a number of these options for controlling the risk factor situations illustrated earlier in Figure 1. Exhibits 15 and 16 illustrate NIOSH efforts to advise companies about engineering control strategies to reduce WMSDs.

Administrative Controls

Administrative controls are management-dictated work practices and policies to reduce or prevent exposures to ergonomic risk

Exhibit 15: Engineering Controls—Beverage Delivery

NIOSH staff conducted an ergonomic study of soft beverage driver-sales jobs. Such job tasks as handling beverage cases for delivery were problematic for two reasons: the stacking of cases in the truck bay exceeded the normal reach limit of workers, and most of the beverage lifting tasks also exceeded the recommended weight limit of the 1993 NIOSH lifting equation. Heart rate measurements, as an indicator of the physical effort required for this work, were found to be high among the driver-sales workers, especially during peak periods. Estimates indicate that more than 35,000 lb of beverage products were handled daily by these driver-sales workers. The rate of musculoskeletal injuries for the affected workforce, in terms of days lost, was twice that of workers in general manufacturing jobs.

To relieve the above-mentioned problems, the following engineering controls were implemented:

- Pullout platform steps in the bay floors enabling the drivers to step up and work at bay level
- External handles between the bays for workers to grab to give them better mechanical leverage during removal of the beverage product
- Multilevel shelving units that provided compartments for different products, gave easier direct access, and eliminated the problem of having to lift or move different products around to find the ones slated for delivery to a customer
- Lubricated two-wheel hand trucks with proper tire pressure maintained to make pushing and controlling the load easier
- Plastic beverage containers instead of glass ones to reduce package weight
- Improved beverage cartons designed with larger handles and smooth, contoured bases that make them easier to handle when removing stacked cartons from the truck

Changes in work risk factors were documented through videotaping, modeling the stresses imposed on the body by the materials handling tasks, continuous monitoring of heart rate, and analyzing discomfort surveys. Data were compared before, during, and after the ergonomic interventions were implemented.

The benefits of the ergonomic interventions were in proportion to the amount of time such controls were used. Reductions in stressors for the back and shoulders were observed when pullout steps, external handles, and multilevel shelving were used. Heart rates decreased for six of nine driver-sales workers during the study period, despite an increase in the product volume handled. The ergonomic interventions reduced the multiple handling of beverage cases and the awkward postures during beverage handling, resulting in a reduced number of reports of fatigue [McGlothlin 1995; NIOSH 1996].

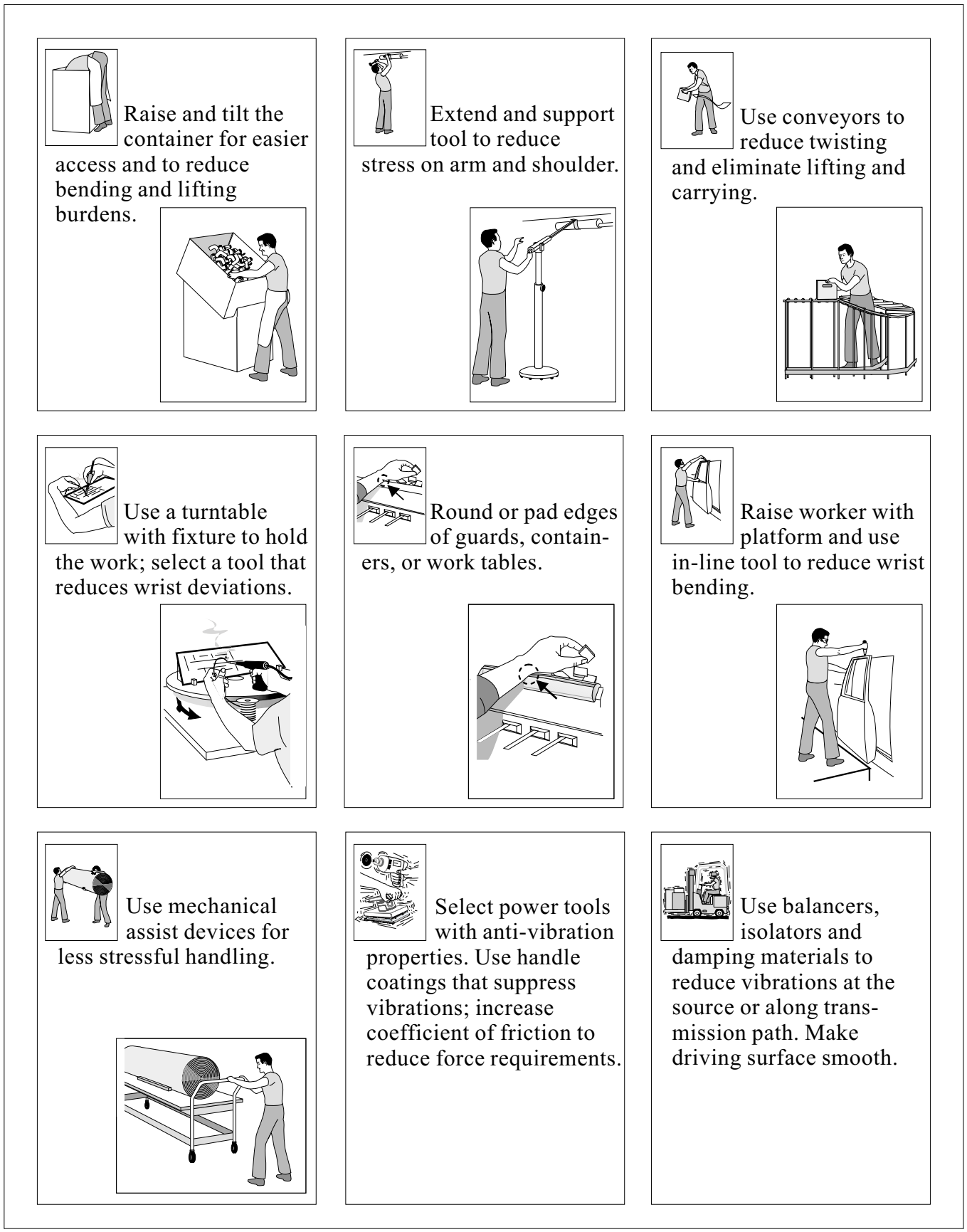

Figure 2. Illustrations of some basic ways for controlling selected risk factor conditions.

Exhibit 16: Engineering Controls—Motorcycle Manufacturing

NIOSH researchers conducted initial and follow-up evaluations of musculoskeletal disorders of the upper limbs and back at a motorcycle manufacturing company. The objectives of this evaluation were to identify the job tasks in the flywheel milling department thought to cause musculoskeletal injuries and to provide recommendations to decrease and prevent such injuries. NIOSH researchers reviewed OSHA Form 200 logs and workers' compensation data and conducted an ergonomic evaluation of four jobs in this department (two flywheel milling jobs, one flywheel truing job, and one flywheel balancing job). Data gathered on the initial site visit in the flywheel milling area showed that repeated manual transport, placement, and removal of the flywheels between milling processes resulted in more than 28,000 lb handled per 8-hour shift. In addition, repeated use of a handheld power grinder to remove metal burrs from milled flywheels proved to be inefficient and presented other accident risks. Analysis of data from the flywheel truing job showed that impact forces from the 5-lb brass hammer repeatedly striking the flywheel ranged from 25,000 to 92,000 lb. Using the NIOSH 1993 lifting equation to analyze the flywheel balancing job showed potential risk for back injury. NIOSH recommended engineering controls to reduce risk factors for musculoskeletal disorders, and the company effected a number of them through establishment of a management/labor ergonomic committee. The engineering controls included the following:

- Upgrading forging and milling machine processes and improving product flow to reduce the burden of flywheel handling from 28,000 to 17,500 lb per 8-hour shift
- Installing a customized 40-ton press to eliminate the use of brass hammers for truing the flywheels
- Using an overhead lift to eliminate manual handling of the 35-lb assembled flywheel unit, further reducing the total weight that had to be handled each day

During a 5-year period from 1989 through 1993, the efforts of the plant's management, engineers, and workers resulted in a reduction of WMSDs involving lost or restricted workdays from 27.6 per 100 workers in 1989 to 12.5 per 100 workers in 1993. The severity of musculoskeletal disorders decreased from 610 lost or restricted-activity workdays per 100 workers in 1989 to 190 workdays in 1993 [HETA 91-0208-2422].

factors. Administrative control strategies include (1) changes in job rules and procedures such as scheduling more rest breaks, (2) rotating workers through jobs that are physically tiring, and (3) training workers to recognize ergonomic risk factors and to learn techniques for reducing the stress and strain while performing their work tasks.

Although engineering controls are preferred, administrative controls can be helpful as temporary measures until engineering controls can be implemented or when engineering controls are not technically feasible. Since administrative controls do not eliminate hazards, management must assure that the practices and policies are followed. Common examples of administrative control strategies for reducing the risk of WMSDs are as follows:

- Reducing shift length or curtailing the amount of overtime
- Rotating workers through several jobs with different physical demands to reduce the stress on limbs and body regions
- Scheduling more breaks to allow for rest and recovery
- Broadening or varying the job content to offset certain risk factors (e.g., repetitive motions, static and awkward postures)
- Adjusting the work pace to relieve repetitive motion risks and give the worker more control of the work process
- Training in the recognition of risk factors for WMSDs and instruction in work practices that can ease the task demands or burden

Two examples of administrative measures are described in Exhibits 17 and 18.

Personal Equipment—Is It Effective?

One of the most controversial questions in the prevention of WMSDs is whether the use of personal equipment worn or used by the employee (such as wrist supports, back belts, or vibration attenuation gloves) are effective. Some consider these devices to be personal protective equipment (PPE). In the field of occupational safety and health, PPE generally provides a barrier between the worker and the hazard source. Respirators, ear plugs, safety goggles, chemical aprons, safety shoes, and "hard hats" are all examples of PPE. Whether braces, wrist splints, back belts, and similar devices can be regarded as offering personal protection against ergonomic hazards remains open to question. Although these devices may, in some situations, reduce the duration, frequency, or intensity of exposure, evidence of their effectiveness in injury reduction is inconclusive. In some instances they may decrease one exposure but increase another because the worker has to "fight" the device to perform his or her work. An example is the use of wrist splints while engaged in work that requires wrist bending. In the health care management section (Step 6), the use of wrist splints or immobilization devices is also briefly discussed.

On the basis of a review of the scientific literature completed in 1994, NIOSH concluded that insufficient evidence existed to prove the effectiveness of back belts in preventing back injuries related to manual handling job tasks [NIOSH 1994]. A recent epidemiological study credits mandatory use of back belts in a chain of large retail hardware stores in substantially reducing the rate of low back injuries [Kraus 1996]. Although NIOSH believes this study provides evidence that back belts may be effective in some settings for preventing back injuries, NIOSH still believes that evidence for the effectiveness of back belts is inconclusive. This area is being researched, and the questions about the effectiveness of most personal equipment remain open. Less controversial types of personal equipment are vibration attenuation gloves [NIOSH 1989] and knee pads for carpet layers [Bhattacharya et al. 1985]. But even here, there can be concerns. For example, do the design and fit of the gloves make it harder to grip tools?

Exhibit 17: Administrative Controls—Jewelry Manufacturing

NIOSH investigators were asked by a jewelry manufacturer to evaluate upper extremity musculoskeletal disorders among employees. Questionnaire surveys of employees indicated that 66% reported work-related upper extremity musculoskeletal symptoms. In the 2 years before the NIOSH evaluation, physicians diagnosed seven employees with carpal tunnel syndrome.

Besides making numerous specific engineering control recommendations, the NIOSH investigators also suggested the following administrative control strategies:

- Training new employees in proper craftsmanship, tool use, and maintenance—for example, emphasizing the need to keep cutting tools sharp to reduce force requirements and the need to keep power tools balanced and lubricated to minimize vibration
- For new employees, providing more frequent rest breaks at the outset to relieve fatigue and overexertion
- Rotating employees to jobs that require the use of different muscle or tendon groups (for example, NIOSH investigators suggested that employees using small handtools be rotated to inspection tasks)
- Providing more frequent breaks for those employees doing polishing, buffing, etching, and engraving tasks because they are engaged in manual tasks for long periods [HETA 90-273-2130]

Exhibit 18: Administrative Controls—Meatpacking

In one meatpacking case, an administrative control approach was used to address ergonomic problems in boning and trimming tasks. Physical stressors of this job included awkward wrist postures, high grip forces, and a high workload. Observations showed that the total boning task workload was 96% of the total task cycle, allowing 4% for rest. In contrast, the trimming task workload was 80% of the total task cycle, allowing 20% for rest. One suggestion was that the trimmers could trim more of the lean shank, reducing the boners' workload. A better balance was struck between these two tasks, and an increase in lean shank yield from this modified job was documented [Gjessing et al. 1994].

IMPLEMENTING CONTROLS

Ideas for controls can be derived from a variety of sources:

- Trade associations may have information about good control practices for addressing different problem operations within an industry
- Insurance companies that offer loss control services to their policyholders
- Consultants and vendors who deal in ergonomic specialty services and products
- Visits to other worksites known to have dealt with similar problem operations

Ideas from these sources are in addition to those ideas gained from brainstorming with employees who perform the jobs or from work teams engaged in such problem solving.

Implementing controls normally consists of

— trials or tests of the selected solutions,

— making modifications or revisions,

— full-scale implementation, and

— follow up on evaluating control effectiveness.

Testing and evaluation verify that the proposed solution actually works and identifies any additional enhancements or modifications that may be needed. Employees who perform the job can provide valuable input into the testing and evaluation process. Worker acceptance of the changes put into place is important to the success of the intervention.

After the initial testing period, the proposed solution may need to be modified. If so, further testing should be conducted to ensure that the correct changes have been made, followed by full-scale implementation. Designating the personnel responsible, creating a timetable, and considering the logistics necessary for implementation are elements of the planning needed to ensure the timely implementation of controls.

A good idea in general is that ergonomic control efforts start small, targeting those problem conditions which are clearly identified through safety and health data and job analysis information. Moreover, the control actions can be directed to those conditions which appear easy to fix. Early successes can build the confidence and experience needed in later attempts to resolve more complex problems.

EVALUATING CONTROL EFFECTIVENESS

A followup evaluation is necessary to ensure that the controls reduced or eliminated the ergonomic risk factors and that new risk factors were not introduced. This followup evaluation should use the same risk factor checklist or other method of job analysis that first documented the presence of ergonomic risk factors. If the hazards are not substantially reduced or eliminated, the problem-solving process is not finished.

The followup may also include a symptom survey, which can be completed in conjunction with the risk-factor checklist or other job analysis method. The results of the followup symptom survey can then be compared with the results of the initial symptom survey (if one was performed) to determine the effectiveness of the implemented solutions in reducing symptoms.

Because some changes in work methods (and the use of different muscle groups) may actually make employees feel sore or tired for a few days, followup should occur no sooner than 1 to 2 weeks after implementation, and a month is preferable. Recognizing this fact may help avoid discarding an otherwise good solution.

In addition to the short-term evaluations using job analysis methods and symptom surveys, long-term indicators of the effectiveness of an ergonomics program can include

— reduction in the incidence rate of musculoskeletal disorders,

— reduction in the severity rate of musculoskeletal disorders,

— increase in productivity or the quality of products and services, or

— reduction in job turnover or absenteeism.

The above-mentioned indicators offer bottom-line results in evaluating interventions that have been put into place. Other indicators may also be used that represent in-process or interim accomplishments achieved on the path to building an ergonomic program—for example, the extent of the ergonomic training given the workforce, the number of jobs analyzed for potential problems, and the number of workplace solutions being implemented. While bottom-line results are most telling in terms of defining a successul program, the interim measures allow the total development to be monitored.

Exhibit 19 describes evaluation techniques used in ergonomic programs at meatpacking plants.

Exhibit 19: Evaluating Ergonomics Programs in Meatpacking Plants

A variety of techniques were used in meatpacking plant ergonomic case studies to evaluate and gauge the effectiveness and benefits of the ergonomic hazard control efforts:

- **Symptom surveys** Two of the case studies described administering symptom surveys to workers before implementation of the demonstration ergonomics programs. The symptom surveys were used to confirm findings from records, help identify problem jobs, and establish baseline data. These baseline data were compared with data from identical surveys administered after controls were implemented. Reductions in the number and severity of symptoms identified during the time period between the first and second survey would be expected if the controls implemented are effective.

  In one case, symptom surveys indicated a decline in the number of people reporting pain and a decline in pain severity. In the other case, symptom surveys showed an increase in the number of reported discomfort areas over the project period. The investigator in this case attributed the rise to increased employee knowledge of ergonomic hazards and WMSDs, as well as to seasonal increases in production.

- **OSHA Form 200 Logs** As with symptom surveys, two of the case studies referred to company-maintained OSHA Form 200 logs to identify problem jobs and establish incidence rates of WMSDs. Data maintained in these logs were used to gauge the plant-wide effects of the ergonomic interventions on overall and job-specific incidence rates of reportable WMSDs. In one case, plant-wide rates were calculated for the two 1-year periods before the study and for two 6-month periods after the interventions. The rates per 200,000 work hours were 55, 75, 80, and 59, respectively. The incidence rates continued to rise in the first 6 months of the post-intervention period, but they fell more than 27% in the second post-intervention period. Reductions in rates of 19%, 33%, and 42% for the second 6-month period were shown in three of the four departments, whereas the rate in the fourth department remained the same.

- **Other records** In these meatpacking case studies, employee absenteeism rates, employee turnover rates (both overall and job-specific), and workers' compensation costs were used to judge ergonomics program effectiveness. In one of the cases, the investigators studied a plant for 7 years. During this period, workers' compensation costs declined to 20% of the pre-ergonomic program costs.

- **Productivity and quality** In one case study, an administrative control for a trimming job resulted in a $14,000 increase in product yield over 6 months. In the same case study, changes in the hog shackling task to reduce back injuries in workers were calculated to yield a $436,000 annual savings from reduced product (hog) loss.

- **Task analysis and checklists** The same techniques used to identify and evaluate the ergonomic risk factors of jobs and tasks were used to gauge the benefits of implemented controls. These were analyzed in terms of the risk factors that were reduced or eliminated from the original, unmodified job. In one case, risk factors such as awkward postures and heavy lifting were reduced or eliminated when mechanized lifts were installed to handle the 250-lb metal tubs while they were being washed [Gjessing et al. 1994].

STEP 6
HEALTH CARE MANAGEMENT

- **Employer Responsibilities**
- **Employee Responsibilities**
- **Health Care Provider Responsibilities**
- **Issues**
  Job Familiarity and Job Placement Evaluations
  Early Reporting and Access to Health Care Providers
  Treatment

Company health care management strategies and policies and health care providers can be an important part of the overall ergonomics program.

In general, health care management emphasizes the prevention of impairment and disability through early detection, prompt treatment, and timely recovery [Hales and Bertsche 1992; Parker and Imbus 1992; American National Standards Institute 1996]. Medical management responsibilities fall on employers, employees, and health care providers.

EMPLOYER RESPONSIBILITIES

The employer can create an environment that encourages early evaluation by a health care provider by taking the following steps:

- Providing education and training to employees regarding the recognition of the symptoms and signs of WMSDs (see Step 3, *Training—Building In-House Expertise*) and the employers' procedures for reporting WMSDs
- Encouraging employees' early reporting of symptoms and prompt evaluation by an appropriate health care provider
- Giving health care providers the opportunity to become familiar with jobs and job tasks
- Modifying jobs or accommodating employees who have functional limitations secondary to WMSDs as determined by a health care provider
- Ensuring, to the extent permitted by law, employee privacy and confidentiality regarding medical conditions identified during an assessment

EMPLOYEE RESPONSIBILITIES

Employees should participate in the health care management process by

— following applicable workplace safety and health rules,

— following work practice procedures related to their jobs, and

— reporting early signs and symptoms of WMSDs.

Employees may be faced with conflicting job demands or requirements. Safe work practices or rules may conflict with pressures or incentives to be more productive.

HEALTH CARE PROVIDER RESPONSIBILITIES

The health care provider should do the following:

- Acquire experience and training in the evaluation and treatment of WMSDs.
- Seek information and review materials regarding employee job activities.
- Ensure employee privacy and confidentiality to the fullest extent permitted by law.
- Evaluate symptomatic employees including:
  - — medical histories with a complete description of symptoms,
  - — descriptions of work activities as reported by the employees,
  - — physical examinations appropriate to the presenting symptoms and histories,
  - — initial assessments or diagnoses,
  - — opinions as to whether occupational risk factors caused, contributed to, or exacerbated the conditions, and
  - — examinations to follow up symptomatic employees and document symptom improvements or resolutions.

ISSUES

Job Familiarity and Job Placement Evaluations

Health care providers who evaluate employees, determine employees' functional capabilities, and prepare opinions regarding work relatedness should be familiar with employee jobs and job tasks. With specific knowledge of the physical demands involved in various jobs and the physical capabilities or limitations of employees, the health care provider can match the employees' capabilities with appropriate jobs. Being familiar with employee jobs not only assists the health care provider in making informed case management decisions but also assists with the identification of ergonomic hazards and alternative job tasks.

One of the best ways for a health care provider to become familiar with jobs and job tasks is by periodic plant walk-throughs. Once familiar with plant operations and job tasks, the health care provider should periodically revisit the facility to remain knowledgeable about changing working conditions. Other approaches that may help the health care provider to become familiar with jobs and job tasks include reviewing job analysis reports, detailed job descriptions, job safety analyses, and photographs or videotapes that are accompanied by narrative or written descriptions of the jobs.

Early Reporting and Access to Health Care Providers

Employees reporting symptoms or signs of potential WMSDs should have the opportunity for prompt evaluation by a health care provider. In general, the earlier that symptoms are identified and treatment is initiated, the less likely a more serious disorder will develop. Employers should not establish policies that discourage employees from reporting symptoms. For example, programs that link a manager's earnings to the number of employees reporting symptoms may discourage supervisors from allowing symptomatic employees to be evaluated by the health care provider. Employees should not fear discipline or discrimination on the basis of such reporting.

Treatment

- Health care providers are responsible for determining the physical capabilities and work restrictions of the affected workers.
- The employer is responsible for giving an employee a task consistent with these restrictions.
- Until effective controls are installed, employee exposure to ergonomic stressors can

be reduced through restricted duty and/or temporary job transfer.

- Complete removal from the work environment should be avoided unless the employer is unable to accommodate the prescribed work restrictions.

- Immobilization devices, such as splints or supports, can provide relief to the symptomatic area in some cases. These devices are especially effective off-the-job, particularly during sleep. They should not be used as prophylactic PPE to prevent the development of WMSDs. Therefore, these devices should be dispensed to individuals with WMSDs only by health care providers who have knowledge of the benefits and possible negatives of these devices. Wrist splints, typically worn by patients with possible carpal tunnel syndrome, should not be worn at work unless the health care provider determines that the employee's job tasks do not require wrist bending. Employees who struggle to perform a task requiring wrist bending with a splint designed to prevent wrist bending can exacerbate symptoms in the wrist because of the increased force needed to overcome the splint. Splinting may also cause other joint areas (elbows or shoulders) to become symptomatic as work techniques are altered. Recommended periods of immobilization vary from several weeks to months depending on the nature and severity of the disorder. Any immobilization should be monitored carefully to prevent complications (e.g., muscle atrophy caused by nonuse).

- The health care provider should advise affected employees about the potential risk of continuing hobbies, recreational activities, or other personal habits that may adversely affect their condition as well as the risk of continuing work without job modifications.

- Oral medications such as aspirin or other nonsteroidal anti-inflammatory agents (NSAIA) are useful to reduce the severity of symptoms. However, their gastrointestinal and kidney side effects make their use among employees who have no symptoms inappropriate and may limit their usefulness among employees with chronic symptoms. In short, NSAIA should not be used preventively.

NIOSH activities in health care management of work-related health problems have included efforts to assess the implementation of such programs. One case is illustrated in Exhibit 20.

Exhibit 20: Medical Management—Poultry Processing Plants

At the request of a State labor department, NIOSH determined the prevalence of WMSDs of the neck and upper extremities in workers employed at two poultry processing plants. OSHA reports and symptom data obtained via questionnaires and physical exams found workers in jobs requiring highly repetitive, forceful motions and awkward postures to have significantly more hand and wrist disorders than those employed in less physically demanding work. In the course of this study, NIOSH also assessed the medical management practices in the two plants with regard to injured workers and the company's WMSD prevention program. Based largely on the questionnaire data and other sources of information, the following areas were suggested as needing improvement or change:

- **Increased nurse access**: From 23% to 29% of employees in one plant who met the various case definitions of upper extremity musculoskeletal symptoms indicated that their foreman or supervisor refused to allow them to leave their workstation to see the plant nurse at some point during the course of the year.
- **More efficient job rotation schemes**: Nearly 30% of the workers in the high exposure jobs in one plant and almost 27% in the second were involved in a job rotation plan. Both plant groups reported spending at least 2 days a week in jobs other than their base jobs. The rotation, however, did not necessarily place them in less ergonomically stressful tasks. Rather, the jobs they temporarily filled were often vacancies on the production line in the same high exposure area.
- **Questionable use of vitamins and anti-inflammatory drugs**: The policy of one plant required all new hires to take ibuprofen tablets and Vitamins E and C several times a day during their probationary periods. Although use of these substances has been advocated as a way to prevent WMSDs, valid, scientific evidence to establish their effectiveness is not available. More importantly, this approach does not substitute for effective engineering or administrative controls. Also, consumption of therapeutic amounts of these drugs (e.g., ibuprofen) can pose a risk of other adverse health effects [HETA 89-307–2009].

STEP 7
PROACTIVE ERGONOMICS

- **Proactive versus Reactive Approaches**
- **Essential Considerations**

Proactive approaches to workplace ergonomics programs emphasize prevention of WMSDs through recognizing, anticipating, and reducing risk factors in the planning stages of new work processes.

PROACTIVE VERSUS REACTIVE APPROACHES

To this point, the elements outlined in this primer and illustrated by NIOSH experiences have represented *reactive* approaches to dealing with workplace ergonomic problems. The steps have offered a plan for identifying problems, specifically WMSDs and job risk factors linked to them, and selecting and implementing measures for controlling them. In contrast, *proactive* approaches are geared to preventing these kinds of problems from developing in the first place. Proactive ergonomics emphasize efforts at the design stage of work processes to recognize needs for avoiding risk factors that can lead to musculoskeletal problems (in effect, to design operations that ensure proper selection and use of tools, job methods, workstation layouts, and materials that impose no undue stress and strain on the worker). One set of guidelines for this purpose can be found in Tray 9 of the Toolbox. Others are illustrated in various ergonomic manuals listed in Tray 10 of the Toolbox.

ESSENTIAL CONSIDERATIONS

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

- Decision-makers planning new work processes, especially those involved in the design of job tasks, equipment, and workplace layout, must become more aware of ergonomic factors and principles. Designers must have appropriate information and guidelines about risk factors for WMSDs and ways to control them. Studying past designs of jobs in terms of risk factors can offer useful input into their deliberations about needed improvements.

- Design strategies emphasize fitting job demands to the capabilities and limitations of workers. Deciding which functions can be done best by machines and which by people is a primary objective. For example, for tasks requiring heavy materials handling and transport, ready use of mechanical assist devices to reduce the need for manual

handling would be designed into the process. Large-sized units could be broken into smaller, more manageable ones, and equipment could be selected that most helps the workers using it.

- Design strategies try to target the causes of potential musculoskeletal problems. For this reason, engineering approaches are preferred over administrative ones because they eliminate the risk factors as opposed to simply reducing exposure to them. For example, having machines do monotonous, repetitive, forceful work is better than subjecting workers to these risk factors. Administrative controls (such as worker rotation or allowing more rest breaks) remain stop-gap measures. They are not permanent solutions.

An example of a proactive approach to ergonomic concerns is illustrated in Exhibit 21.

Exhibit 21: Proactive Ergonomics at an Appliance Manufacturer

NIOSH, as a demonstration project, is assisting an appliance manufacturer in designing a new assembly line that, by incorporating ergonomic factors, can prevent musculoskeletal disorders without limiting production output. Steps in the project include the following:

- Evaluating musculoskeletal injury patterns associated with work on existing production lines, observing related risk factors, and determining engineering solutions for these risk factors
- In-house training of assembly line workers, engineers, and management to recognize, evaluate, and provide solutions to job risk factors
- Applying the above training information in the planning of a new assembly line with the goal of preventing musculoskeletal disorders
- Conducting a symptom survey of the assembly line workers at the beginning of the new line's production to establish baseline morbidity rates
- Fine tuning the production line with ergonomic controls as production increases and as workers become more knowledgeable and skilled in their jobs
- Conducting periodic follow-up symptom surveys to determine injury trends and outcomes

NIOSH interactions with the plant's design, manufacturing, and production engineers are aimed at shifting the engineers' thinking from just production issues to include ergonomic concerns. The following are some benefits resulting from these interactions:

- The design and use of a tool-balanced, in-line screw gun with torque control. The torque control is achieved by attaching an "L"-shaped handle called a "cheater bar" to the tool. This design allows the torque resulting from driving screws with this tool to be transferred to the bar, which is stabilized by holding it against the edge of the metal cabinet of the washer or dryer. In so doing, the torque force is not absorbed by the tool user.
- Using a pneumatic tool to open the hose clamps needed to attach hoses to the drain valves of washing machines. The original task was performed with a pair of pliers. This change reduces the static forces and awkward postures required for attaching the hose to the valve.
- Using height-adjustable worktables and height-adjustable shelving units, allowing workers of different heights and arm lengths to assemble parts with more ease and comfort.
- Using a pneumatic lift and rotation table to lift the washers to the desired standing height of the worker so they can drive in screws without stooping over, and rotating the tables so that all screws can be fastened from one workstation.
- Building an assembly line with these ergonomic workstation features may be less costly than retrofitting existing lines. Another advantage is that the worker is learning to do the job in ways that are more healthful and more productive [Estill and McGlothlin 1994].

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