CHAPTER 1
PREVENTION

GENERAL PRINCIPLES

Prevention of work-related health complaints should be a top priority for occupational health professionals. Diagnosis and treatment of workers presenting with work-related health problems represent an opportunity to prevent recurrences in those workers (tertiary prevention), to mitigate the effects of current work-related hazards so as to reduce the duration of the problem (secondary prevention), and to prevent the same problems in coworkers and those in similar jobs (primary prevention).

Occupational health professionals can often identify opportunities for prevention. Understanding job and work requirements may suggest possibilities for primary prevention of work-related illness or injury through hazard identification. A workplace ''walk through'' is also useful to attain familiarity with job requirements and the work environment as one element of fitness-for-duty assessment. The discovery of significant work factors suggests that worksite intervention to prevent recurrences and hasten recovery may well be appropriate.

A cluster of cases in a work group suggests a probability of previously unidentified problems in work design or management. The presence of work-related discomfort, illness, or injury should trigger a search for causes (see Chapter 4, "Work-Relatedness") and plans for remediation. Different levels of certainty about the cause of the problem and differences in the severity of the adverse effects on health may justify different levels of response.

The practitioner's task in prevention is first to identify associated or causative workplace and personal factors. The practitioner should then suggest scientifically based selection and screening of personnel and engineering controls and task or job redesign, as well as treatment and disability management of the immediate health problem. Further preventive efforts may include personal protective equipment, administrative changes, education, and training at all levels of the company; close attention to the psychological needs of the employees; proper medical surveillance of the workplace; and the opportunity for contact with a health care provider if questions or complaints arise. Whether the job is a match with the capabilities of the individual worker should be investigated. There is enough variation in strength, flexibility, endurance, healing capacity, anatomy, and other factors among workers that individual investigation is warranted because statistical risks apply only generally to individuals (see "Person-Job Fit").

EVALUATING THE EVIDENCE FOR PREVENTIVE ACTION: CAUSATION AND ASSOCIATION

DIAGNOSIS: KEY TO ANALYZING ASSOCIATION

The first element in seeking an association between a work-related health problem and a worksite factor is an accurate diagnosis. Epidemiologic studies generally correlate exposures with specific pathologic entities. Alternatively, some studies have correlated levels of symptoms, rather than diagnoses, with worksite exposures or tasks. These correlations are useful to help prevent health-related ''complaints,'' but increased frequency or intensity of symptoms alone should not be equated with causation or potential prevention of specific pathologic entities (e.g., diagnoses), such as carpal tunnel syndrome or disk herniation, for example.

USE OF QUALITATIVE INFORMATION

Occupational health practitioners making recommendations for prevention of work-related complaints are still faced with a lack of quantitative associative information for many common problems. An individual worker's symptoms themselves may decrease productivity and cause discomfort. As such, clinicians are obligated by public health principles to mitigate the symptoms and to prevent a delay in recovery and recurrences in the individual as well as occurrences in others. Such actions often must be taken on a case-by-case basis using information about worker-job fit as well as preliminary or population data.

The current scientific literature about potentially work-related musculoskeletal disorders (WRMSDs), degenerative disorders such as degenerative joint or disk disease, and a number of other nonspecific symptoms and conditions (e.g., visual fatigue, commonly known as "eye strain," and associated headaches and neck and shoulder complaints, stress-related complaints, nonspecific chest pain, respiratory symptoms thought to be due to indoor air pollution, and others) is notable for a lack of studies that temporally and quantitatively define causal associations of work exposures. There are very few prospective studies; most are cross-sectional or case-control studies, which do not allow determination of temporal association. Other information is derived from physiology laboratory measurements rather than clinical observation in real work situations.

Further, almost all available studies either define exposure to work-related factors qualitatively or use job title as a proxy. In almost all cases there has been no quantification of specific ergonomic or other stressors to allow determination of a dose-response curve. If there were dose-response relationships, one might find thresholds at which WRMSDs and other work-related symptom complexes might or might not occur. Thus, at present, risk factors that have been found to be associated with or predictive of certain WRMSDs and other syndromes have not necessarily been found to be causal for these entities. Due to the absence of certainty regarding causality and the lack of quantitative exposure-response data, most recommendations for the prevention of WRMSDs will be qualitative. While practitioners must make good-faith efforts to prevent these complaints, these assumptions should not extend to opinions about causation for benefits or medicolegal purposes. The commonly seen statement "in the absence of other obvious causes, the problem is work-related" is at odds with scientific logic and should not be used (see also Chapter 4).

COMPLEX CAUSATION

The occupational health practitioner also should be aware that many musculoskeletal, psychological, and other problems often are caused by several work- and non-work-related factors in varying combinations. Many potentially work-related complaints result from more than one factor. Some factors are work-related and others are personal. The work factors are necessary, but not sufficient in many cases. For example, not all workers exposed to certain numbers of repetitions and degrees of force during hand manipulations will develop tenosynovitis of the wrist and hand, but a few of them would develop the problem without significant ergonomic exposure at work or during performance of non-job-related daily activities or a hobby. In other cases, there may be a variety of possible causes for a disorder or complaint as well as personal and work factors that come into play. For example, pregnancy, hypothyroidism, or obesity may be associated with carpal tunnel syndrome in susceptible individuals. Population studies have identified such competing causes in a number of instances (see Chapter 4 for further details). Both work and personal factors may need to be addressed to prevent initial episodes, delayed recovery, or recurrences.

CHRONIC PAIN VERSUS WORK-RELATED PROBLEMS

Practitioners should be very careful to differentiate work-related problems from chronic pain (see Chapter 6). Musculoskeletal pain that develops with minimal exposure to defined work factors, that is related to positioning of equipment, and that involves several areas of the back or upper extremities may well be chronic pain that is not specifically related to job or task design. A history of such symptoms currently or in the past is helpful in making the distinction. These cases are often costly and involve a great deal of lost time and ineffective treatment.

PERSON-JOB FIT

Many "personal factors" are in reality a mismatch between the worker's abilities and job demands, or person-job fit. Ensuring proper person-job fit is important to prevent discomfort, loss of productivity, and physical injury to workers. (One conceptual view characterizes a person-job mismatch that leads to symptoms or the development of diffuse pain at work as work intolerance.) The general duty to provide a safe workplace mandates proper placement of workers while avoiding unjustifiable discrimination.

Workers may vary in their capacity to lift, exert force, perform fine motor tasks, etc. according to general or specific health status, age, conditioning, size, strength, and other factors. Physical functional abilities rise and fall over the worker's lifespan. Abilities also vary from worker to worker depending on conditioning, impairment, and innate capacity. The decline in cardiorespiratory and musculoskeletal functional capacity with age can be delayed or accelerated by physical conditioning (or lack thereof), overuse, illness (including chronic pain), and injury.

The visual system also undergoes predictable and anticipated changes during the lifespan of an individual. The natural hyperopia (far-sightedness) of an infant tends to lessen or to transition to myopia (near-sightedness) at approximately 20 years of age. All eyes have a progressive decrease in accommodation (focusing at near point).[1]

FITNESS-FOR-DUTY EVALUATION: ASSESSING PERSON-JOB FIT

Occupational physicians are often called on to determine this person-job match, sometimes termed "fitness for duty." To determine fitness for duty, it is often necessary to "medically" gauge the capacity of the individual compared with the objective physical requirements of the job based on the safety and performance needs of the employer and expressed as essential job functions. However, an objective statement from employers of the physical requirements of the job may not be available to physicians, so such assessment may be performed without complete workplace information. Further, as noted earlier, studies correlating physical testing with risk of complaints or injuries often are not validated or not available.

On a practical level, the fitness-for-duty evaluation of a worker must address a continuum of historical and physical findings from reports of occasional symptoms of musculoskeletal discomfort to a definitive diagnosis and active evidence of a significant musculoskeletal disorder that may functionally limit the individual. The challenge is to fairly and accurately evaluate the individual for fitness to perform the job, often not on the basis of quantifiable risk, but on professional opinion regarding what he or she can or cannot do. The worker's past history of pain or dysfunction in specific work settings can be quite useful in gauging the probable reaction to work factors, positioning, scheduling, the need for stretching and activity breaks, etc. For those whose work entails significant physical labor, a change in career or work duties may be necessary due to the decline in functional capacity with age or other factors. This also may be true of patients with current or past diffuse, rapid-onset, or chronic musculoskeletal pain.

Employers should carefully assess whether employees can tolerate a given job or work environment either at the time they are initially employed or on a routine basis subsequently, particularly when job requirements mandate a certain level of physical conditioning or, at the very least, the absence of undue sensitivities to physical, environmental, or mental stress. In circumstances where employees' physical or mental abilities are not compatible with job and worksite requirements due to baseline factors or due to aging or disease, it is not uncommon for them to experience physical or mental discomfort in the course of their employment.

Employers who consider worker-job fit may be able to prevent both injuries and symptomatic "work intolerance." In the case of age-related capacity, the first step is to identify particularly demanding jobs that are unlikely to remain suitable for employees until retirement. In identifying such jobs, one should be cognizant of high-grade evidence of increased incidence of symptoms or of injury with age, if it exists. (In many cases, it does not; see Chapter 4.) Speculation should be avoided. The next step is to discuss these issues explicitly within the company, with involved employees, and to anticipate the need for long-term succession plans to shift the duties of workers as they age.

PSYCHOSOCIAL FACTORS AND PERSON-JOB FIT

Employees who are invested in remaining at work will try to overcome obstacles resulting from work intolerance, perhaps by adapting or changing work practices to their abilities. Workers who are experiencing other forms of job-related dissatisfaction are less likely to seek to match their abilities to work demands.

[1] Infants have natural hyperopia of 2 to 30 diopters. At age 10, the amplitude of accommodation is 14 diopters, declining to 4 diopters at age 45 and 1 diopter at age 60. (It takes 3 diopters at the near point of accommodation to keep a target at 1 meter in focus.)

PREVENTIVE STRATEGIES AND TACTICS

Different strategies are needed to prevent first episodes of symptoms or activity limitations, to prevent recurrent episodes, to prevent or reduce lost workdays due to injury, to prevent chronic disability, and to reduce or prevent medical care utilization and its associated cost. Occupational health professionals should be clear about the goals of specific preventive efforts.

PRIMARY PREVENTION

From a public health point of view, primary prevention is preferable to secondary and tertiary prevention. The primary prevention of work-related disorders depends on the reduction or elimination of exposure to factors causally associated with those disorders in individuals susceptible to such stressors. In the past, emphasis has been placed on risk factors that are physical in nature, such as force, repetition, posture, vibration, lighting, terminal design, and posture. However, other factors, such as worker job satisfaction and relations with coworkers and supervisors, have been specifically noted to have a relatively strong relationship to musculoskeletal, visual, and other apparently ergonomic complaints.

The primary prevention of work-related complaints thus depends on reducing exposure to physical, personal, and psychosocial stressors. For example, engineering controls, including ergonomic workstation evaluation and modification, and job redesign to accommodate a reasonable proportion of the workforce may well be the most cost-effective measures in the long run. Personal protective equipment also can be an effective strategy for primary prevention. Primary preventive strategies based on maintaining activity and flexibility, such as exercise breaks for workers performing assembly tasks or a scheduled rotation of tasks, appear to be low in cost and generally effective based on physiologic principles. Strategies that improve work organization and management also should be addressed.

WORK DESIGN

Several general principles are important to prevent musculoskeletal disorders and visual fatigue or injury. These include protection from hazards via engineering controls (effective barriers to hazards), use of personal protective equipment, administrative controls, and adjustment of workstations, tasks, and tools to the individual worker's size and physiologic and work capacity.

Person-job fit is a basic principle that may markedly reduce occupational health concerns and the costs of lost productivity due to illness and injury as well as related medical costs. The same principles are used either to engineer jobs so that they fit many people or to adapt a job, task, or workstation to a specific person. These principles include:

- Decreasing force or load as well as repetitions through redesign, tool changes, or automation.
- Decreasing static exertions that result in excessive muscle fatigue.
- Providing reasonable and prudent exercise breaks, depending on the tasks involved. For example, stretch or light-exercise breaks may be reasonable every half hour or hour for static, repetitive, or sedentary jobs or tasks.
- Avoiding use of the hand as a tool, such as pounding on a tool or part.
- Providing lift-assist devices, particularly for those performing frequent, heavy lifts.
- Positioning work to avoid static, nonanatomic postures resulting in sustained muscle contraction.

Jobs and workstations should be designed so that they fit most workers' capacities. Workstations, equipment, or task components should be adjustable for workers of different stature, strength, and endurance to ensure a match between each worker and his or her tasks, thereby avoiding discomfort, loss of productivity, and injury. Management practices and psychosocial factors as they relate to person-job fit also should be assessed.

Ergonomic Tactics to Prevent Upper-Body Musculoskeletal Complaints and Disorders. In making recommendations for the design of tasks and workstations to prevent upper-body health concerns, the occupational health provider should be aware of the physical dimensions and range of motion needed to complete the tasks involved if they are well designed. The tools, machinery, or workstations should be flexible enough to accommodate any worker. Workers may be involved in the identification of physical job requirements and discomfort or overload situations by means of interviews, group sessions, and/or questionnaires and scales. Ergonomic research supports the following recommendations for the design of tasks that involve use of the neck, shoulders, and upper extremities in order to prevent musculoskeletal complaints and injuries:

- Jobs that require overhead reaching, work under load in that position, or hyperextending the neck should be modified to minimize these postures and movements in order to reduce shoulder and neck complaints as well as lack of visibility, especially in workers with presbyopia.
- Workstations should be designed to avoid repetitive twisting of the neck to refer to written materials.
- In a job where the operator is sedentary, he or she should be able to reach all materials and equipment without leaning, bending, or twisting at the waist. Twisting while bearing a load should be avoided whenever possible by proper placement of work materials. Reaching overhead and far to the sides, resulting in twisting motions of the torso, should be avoided. Proper placement of work materials within about a 90-degree arc, centered in front of the worker, minimizes reaching outside the "reach envelope." The forearm-only reach is preferable, although the full-arm reach is acceptable.
- Design of hand tools should be determined by hand anatomy and task design to:
  - Avoid ulnar or radial deviation or flexion or extension at the wrist.
  - Maximize grip strength by avoiding palmar flexion and other wrist deviations.
  - Provide as great a force-bearing area as possible in handles and grips.
  - Minimize the force and vibration transmitted to the hand and upper body.
  - Avoid repetitive finger action.
- To avoid neurovascular as well as tendon injury, the hand should not be used as a hammer.
- Vibration transferred to the hands, wrists, and remainder of the upper extremity should be reduced to the extent possible through the use of vibration-damping wrappings and coatings, isolation suspension of vibrating machinery, or automation.
- Management support and participation in prevention programs, especially for repetitive-motion complaints, is often as important as mitigation of physical factors. Factors such as monotonous work, high perceived workload, low control or autonomy, and low levels of support should be addressed.

Ergonomic Tactics to Prevent Neck and Back Musculoskeletal Complaints and Disorders. Ergonomic research supports the following recommendations for the design of tasks that involve use of the neck and back in order to prevent musculoskeletal complaints and injuries:

- Twisting and bending while bearing a load should be avoided whenever possible by proper placement of work materials.
- Reaching outside the "preferred work area" should be avoided whenever possible by proper placement of work materials within approximately a 90-degree arc centered in front of the worker.
- Frequent bending and stooping, especially below knee level, should be avoided by:
  - Placement of the load.
  - Use of mechanical lifting devices.

- The following lifting recommendations are based on the National Institute for Occupational Safety and Health (NIOSH) *Applications Manual for the Revised NIOSH Lifting Equation* (revised 1991). Lifting should be:
    - Planned so as to conform to the following and to avoid slippery or cluttered areas:
        - Close to the body.
        - Between knee (preferably waist) and shoulder height.
        - Without bending or twisting the back.
        - With the chin tucked in, if lifting overhead.
        - With well-designed, secured handles (if handles are used).
        - Less than 50 percent of a worker's capacity (personal strength limits), as determined by preplacement testing.
        - Generally less than 25 to 35 pounds (11.3-15.8 kilograms), unassisted.
        - Less frequent than 20 lifts per minute, depending on lifting technique, physical conditioning, and personal factors.
        - Slow, with at least 3 seconds per lift.
- Pushing and pulling should be limited to forces of less than 50 pounds (22.5 kilograms) at the hands.
- Heavy carrying should be reduced to less than 33 percent of lean body weight by:
    - Dividing loads.
    - Use of mechanical transport devices.
    - Using more than one worker to move heavy loads.
    - Task assignment tailored to each worker and load size.
- The use of back belts as lumbar support should be avoided because they have been shown to have little or no benefit, thereby providing only a false sense of security.
- Unexpected movements should be avoided by:
    - Ensuring strong, easily gripped, thick handles with rounded edges.
    - Removal of slip, trip, and fall hazards.
    - Planning lifting maneuvers.
- Prolonged sitting and standing should be reduced by:
    - Providing rest and exercise breaks.
    - Task rotation or variation.
- Seating should generally be at a height of 16 to 20 inches (40-52 centimeters) with a lumbar support, adjustable reclining back (90-140 degrees), and a firm, flat, adjustable seat pan with a rounded edge no longer than 16 inches (40 centimeters) for prolonged sitting. Mobile workers may prefer a sit-stand option using a high stool with a seat 29 to 32 inches high (74-81 centimeters). Seating of the first type and sit-stand stools support back musculature and minimize intradiskal pressure. Foot rests and/or armrests may be needed for some workers. All seating should be fully adjustable to accommodate workers of different heights and body habits.
- Job stress should be reduced and job satisfaction and task enjoyment should be increased by:
    - Varying repetitive or monotonous work.
    - Increasing workers' control over tasks.
    - Designing jobs so that workers see the output of their work.

  - Increasing workers' participation in decision making.
  - Matching authority and responsibility in jobs.
- Repetitive and monotonous work should be reduced whenever possible by:
  - Automatic feed devices.
  - Task, job, or worker rotation.
  - Breaks and exercises to maintain alertness.
- Whole-body vibration, such as that from motor vehicle and machinery operation, especially in the range of 4 to 8 cycles per second (but including 2 to 11 cycles per second), should be reduced as much as possible by:
  - Mechanical damping or balancing of machinery.
  - Damping cushions and padding.
  - Automating processes.
- The level of exertion should be limited to about 33 percent of a worker's aerobic capacity, as determined by preplacement testing. Anaerobic exercise may lead to fatigue-related errors and overload.
- Routine exercises specific to the back and neck have been shown to be a preferred and effective utility in the prevention of neck and back strain and should be part of daily work for those at risk of developing musculoskeletal complaints.

Ergonomic Tactics to Prevent Visual Fatigue and Other Visual Disorders. "Visual fatigue" is a term used to describe phenomena related to intensive use of the eyes. It can include complaints of eye or periocular pain, itching or burning, tearing, oculomotor changes, focal problems, performance degradation, "aftercolors," and other phenomena. Ergonomic research supports the following:

- Placement of frequently used displays in the primary visual display area. The top of this area should be opposite the operator's eyes, with the eyes facing straight forward, extending down to a point where the operator is looking down at a 30-degree angle. Devices viewed as they are operated, such as buttons, keyboards, and controls, should be above and below this area, at the work surface, and above the plane of the operator's eyes.
- The optimal viewing distance for visual displays is about 20 inches (50 centimeters). Corrective lenses designed specifically for fine details, including display-screen work, can be used for workers with refractive error or presbyopia. Lenses of this type can be incorporated into multifocal eyeglasses as well.
- Proper illuminance is important. It should be evaluated for each task. It depends on the needs of the task, reflectance of surfaces in the area, and to some extent the age of the worker because older workers generally require brighter lighting with less glare for visual discrimination. In general, luminance of 70 to 80 footcandles is needed for general office work, 100 to 150 footcandles for visually intensive tasks, and up to 500 to 1000 footcandles for very fine tasks. Specific task lighting is preferred, when needed, over excessive ambient area lighting.
- Lighting geometry should be configured to avoid glare. Glare should be reduced for display terminals by:
  - Placing visual display terminals out of direct line with windows.
  - Use of window films and coverings.
  - Use of dull, textured surfaces.
  - Reducing ambient lighting to below 500 lux (18-46 footcandles) and using supplemental lighting where needed.
  - Use of indirect lighting.

    - Parabolic louvers on fluorescent lights.
    - Shielding of auxiliary lighting.
    - Use of eye shades.
- Visual discomfort from glare and other sources cumulates during the workday, so task rotation may be a reasonable preventive measure if other measures are not possible or reasonable.
- Visual performance can be impaired by whole-body vibration in the range of 10 to 25 cycles per second. Such vibration, which may be generated by power saws, cranes, conveyors, and other machinery, should be damped or separated from the worker.

Periodic short periods of rest from fixed focal tasks for data-entry workers and other computer-related positions, such as a 5-minute period involving fixation of the eyes to infinity every 20 to 40 minutes, helps to reduce eye strain and discomfort while improving mood and performance.

PERSONAL RISK MODIFICATION

Strategies based on modification of individual risk factors (e.g., improving worker fitness, smoking cessation, weight loss) may be less certain, more difficult, and possibly less cost-effective. In particular, abdominal muscular strengthening to prevent low back pain is not supported by the existing evidence, whereas good aerobic condition is associated with a lower injury rate. Improving flexibility and strengthening of specific areas, such as the shoulder girdle, are recommended elsewhere (see Shoulder Disorders Chapter, for example). An emphasis on aerobic conditioning may be appropriate to prevent musculoskeletal disorders. Aerobic fitness has other benefits as well, including improved productivity and job satisfaction.

Training in body mechanics and conditioning (sometimes referred to as "work hardening") also have been advocated to prevent musculoskeletal disorders and visual fatigue. While high-grade evidence supporting the efficacy of training in body mechanics is sparse, it is a logical step (perhaps primarily to prevent recurrences) and is supported by many experienced occupational health providers. Work hardening, in the form of conditioning at hire or reconditioning after absence from work for the specific demands of the job, is also a logical step from a physiologic standpoint because deconditioning has been implicated in both initial complaints and recurrences. However, because the evidence is inconclusive, these efforts may be more cost-effective if their focus is the prevention of recurrences rather than primary prevention.

PREPLACEMENT AND PERIODIC EXAMINATIONS

The preplacement/postoffer medical examination also may aid in reducing the risk for development of WRMSDs or other health conditions. The clinician must be clear about the purpose of the examination and its components. The examination should be designed by defining the type and level of risk to the worker and to others. In general, these examinations are most productive as selection screening in relation to the demands (time, load, repetitions), consequences of error, and person-job fit in areas of high injury with high job demands. The purpose of preplacement examinations should be narrowly job-related; their intention should not be to discover hidden diseases and treat them. Preplacement examinations may be used to establish a baseline, especially in workers who have sustained previous injuries or illnesses. It should be noted that these examinations typically are not regarded as establishing a doctor-patient relationship.

Job requirements should be in written form and should be framed in relation to quantified physical demands of the job, especially its essential functions. Quantified or statistics-based scales that rate or list physical demands, emotional demands, hours, working conditions, special equipment and tools used, faculties needed, and vocational qualifications can form the basis for evaluation of job requirements. A combination of descriptions by supervisors, site visits, and a group process used by teams of workers to define actual tasks (the Santa Barbara protocol), videotapes of the job as typically done, or structured questionnaires provides the necessary information for creating the most accurate job descriptions.

In evaluating the ability of a worker to do the job as described, the history is very important. If the candidate has had trouble with a similar job or demand in the past, this is a sensitive indicator for job evaluation or accommodation. The clinician must be aware of the sensitivity and specificity of any tests used and their applicability to real job situations. Tests should have been evaluated in working populations and determined to reflect true job demands. At present, there is not good evidence that functional capacity evaluations are correlated with a lower frequency of health complaints or injuries. The preplacement examination process will determine whether the employee is capable of performing in a safe manner the tasks identified in the job-task analysis.

If a more comprehensive preplacement examination is done for health promotion or protection purposes, it may identify other risk factors and conditions such as obesity, thyroid disease, poor muscular conditioning, pregnancy, diabetes, and certain congenital anomalies. The employee should be counseled about factors associated with WRMSDs or other work-related health concerns and potential risks, particularly if he or she has anypreexisting medical conditions. This process also allows the health care provider to communicate to the employer the need for appropriate restrictions, accommodations, or task redesign that would permit the employee to work safely.

PHYSICAL HAZARD CONTROL

If it is likely that physical work factors may contribute to subjective or objective health effects, the occupational health practitioner and the employer should consider methods of hazard control to mitigate the observed effects and improve productivity. Systematic job-task analysis will identify ergonomic and physical risk factors associated with various tasks. This identification should then lead to the implementation of appropriate control measures to reduce employee exposure to these risks. The following methods of physical and ergonomic hazard control are listed in order of preference:

Engineering controls. Engineering controls that reduce exposure levels are the preferred method of preventing the development of work-related musculoskeletal health effects. Engineering controls focus on job tasks or processes. Direct engineering changes in job operations may be made to minimize exposure of workers—for example, use of light curtains, barriers, or enclosed processes. To prevent job-related health effects due to ergonomic problems, the preferred means may be the development of special tools, jigs, or balances or the adjustment of workstations to fit each individual. A change in the work process itself can reduce exposure levels of various types significantly. Engineering change is best able to alter levels of necessary force; abnormal posturing, vibration, noise, and temperature; and exposures to chemical and physical hazards. The implementation of proper engineering controls may not preclude the need for administrative controls, employee training, or personal protective equipment, however. The implementation of engineering controls to reduce exposure levels is also the preferred method of controlling the development of work-related nonspecific eye complaints. However, personal protective equipment is often more practical.

Administrative controls. Administrative controls focus on the worker's capabilities and motivations and how the job task is done. These controls include job rotation, task separation, elimination of production incentives, reduction of overtime, optimal assignment of shift work, and the provision of appropriate break times. The implementation of such controls can reduce repetition rates and total repetitions, improve recovery time, and reduce the exposure to stressors. Administrative control also should be implemented to alter work-organization tasks that affect the psychological state of the employee. Psychosocial factors that have been associated with work-related complaints include job dissatisfaction, low enjoyment of tasks, poor relationships with supervisors or coworkers, excessive workload, low workload/monotony, ambiguity over career development, lack of employee control, social isolation, deskilling due to a single repeated job task, and simply individual differences leading to poor person-job fit. In some instances, psychosocial stressors have been found to be as important in contributing to work-related complaints as physical stressors.

Personal protective equipment. If engineering controls of physical, chemical, or biologic hazards are not feasible, appropriate and effective personal protective equipment (PPE) should be used. Hearing protection, impervious gloves, boots, respirators, and eye and face protectors are well-known examples of PPE. However, there are no forms of PPE that well-designed studies have proved effective in preventing WRMSDs.

MANAGEMENT EDUCATION

Education and information should be provided at all levels of a company. Upper management must understand the risk for WRMSDs, eye, hearing, and respiratory complaints and other health problems in the workforce; the financial and social cost associated with them; and the need for management's support of line supervisors to implement risk factor controls. Further training may be needed for environmental safety and health staff, plant engineers, human resources personnel, ergonomic teams, and the individual employees themselves. The Occupational Safety and Health Administration (OSHA) [29 CFR 1910.132] requires training on the workplace hazards and use of specific PPE to prevent injury for each of the tasks being performed.

EMPLOYEE EDUCATION AND INVOLVEMENT

Employees should have a baseline knowledge of the risk factors for work-related complaints, how to prevent them, and how to access medical care if a health concern develops. Employees also should understand their job responsibilities, job requirements, and duty to comply with health and safety standards developed by both regulatory agencies and the employer.

Employees should be encouraged to participate with management in identifying work factors associated with health concerns, and in suggesting methods to control exposure to them. Active participation may facilitate secondary and tertiary as well as primary prevention.

In making realistic recommendations, occupational health professionals also must balance the cost of preventive efforts (in time, effort, and money) against the expected benefit of designing broad-based or targeted programs. For example, some primary preventive efforts, such as back education or fitness programs, are often applied for all workers. However, back pain, while the most common complaint seen in occupational medicine, affects less than 2 percent of most workforces yearly, and about 10 percent of those workers account for more than 80 percent of the costs. In addition, because of the state of knowledge and individual variation in susceptibility and presence of non-work-related risk factors (see preceding discussion and Chapter 4), broad-based prevention efforts for some types of initial or recurrent health concerns may not be cost-effective. Effective targeting of preventive efforts may be difficult as well. A focus on secondarily preventing disability, which often leads to high-cost cases, may prove to be more cost-effective.

SECONDARY PREVENTION

Secondary prevention consists of detection and surveillance programs designed to identify early indicators of difficulty (e.g., symptoms, minor injuries, sprains, strains) and intervention to avoid re-injury and/or the worsening of conditions, including iatrogenic disability. Secondary prevention is aimed at reducing disability and hastening recovery once a health concern has become apparent. This is a more targeted approach, in that it has become apparent which workers will develop complaints, illnesses, or injuries. Since secondary prevention involves working in partnership with the worker, the cornerstones of this process are two-way communication, addressing myths and misconceptions, management of expectations, bilateral or trilateral planning, and management of the episode and the situation, as outlined in Chapter 3, "Initial Approaches to Treatment."

Modified or temporary duty is important to return workers to the worksite and prevents social isolation and deconditioning (see Chapter 5, "Cornerstones of Disability Prevention and Management"). Reconditioning and avoidance of static postures are important in musculoskeletal disorders both to hasten functional recovery and to prevent recurrences. Back schools are an example of an approach that combines these two areas with imparting of information and group support. Any problems with workstation or task design that contributed to the original problem should be corrected to avoid aggravating the condition.

SURVEILLANCE

Occupational health professionals may work with employers to develop and implement a surveillance system for the detection of work-related health complaints that may cause discomfort, develop into fixed pathology, or impair productivity. The components of an occupational surveillance program are the detection and enumeration of job-related morbidity and mortality, characterization of trends and identification of new patterns or clusters of disease, and monitoring of interventions to decrease frequency or severity. Health surveillance may identify a pattern of development of musculoskeletal, ocular, or other symptoms or of adverse health effects associated with some tasks that could not be predicted through task analysis. This is especially true when development of these conditions is associated with psychosocial more than physical factors.

Passive health surveillance may include retrospective review of OSHA logs, absenteeism records, or documents from workers' compensation insurers. Active health surveillance may include questionnaires or routine medical examinations or both. Well-designed medical surveillance may allow the employer to focus resources on those tasks that appear to be most predictive of development of musculoskeletal or other adverse health effects.

TERTIARY PREVENTION

Tertiary prevention is vocational rehabilitation and functional restoration in a worker who has had a major alteration in work capacity or life whether due to a major biologic event (e.g., catastrophic injury, severe disease) or a constellation of factors (e.g., iatrogenic disability). Tertiary prevention in the work setting involves prevention of recurrences in a patient who has had a previous episode. The first action should be to evaluate the job or tasks and the person-job fit and then to modify the job, tasks, or workstation as necessary (see "Work Design"). Excessive loads, repetitions, abnormal postures, and other ergonomic problems should be addressed.

If the individual cannot do the job as originally designed due to an impairment, reasonable accommodation should be attempted. If this is not possible, job placement elsewhere or retraining may be necessary.

As noted, reconditioning and avoidance of static position for long periods of time should help to prevent recurrences. Both aerobic conditioning and conditioning of specific muscle groups (e.g., forearm muscles or neck and shoulder musculature) should reduce the risk of future health problems.

REFERENCES

BIOMECHANICS

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