An Introduction to the Principles of Occupational Ergonomics

Linda Frederick, RN, MSN, Ergonomics Specialist/Occupational Health Nurse, Division of Biomedical and Behavioral Science; **Daniel Habes, MSE,** Industrial Engineer, Division of Biomedical and Behavioral Science; **Joann Schloemer, RN, MEd,** Technical Information Specialist/Occupational Health Nurse, Division of Standards Development and Technology Transfer, Department of Health and Human Services, Centers for Disease Control, National Institute for Occupational Safety and Health, Cincinnati, Ohio.

ABSTRACT

Occupational ergonomics is a discipline which attempts to adapt the job to the worker with the goal of promoting worker health, safety, and comfort as well as productivity. This paper presents an introduction to the principles of occupational ergonomics, and lists some items to consider when performing an ergonomic evaluation of the workplace. The goal of this communication is to increase the occupational health nurse's awareness of, and ability to identify and prevent, ergonomic hazards in the workplace.

INTRODUCTION

Musculoskeletal disorders are a leading cause of disability among people in their working years (Kelsey, Pastides & Bisbee, 1978). In 1972 the total economic cost attributed to musculoskeletal disorders was estimated to be $20 billion per year, second only to circulatory diseases (Kelsey, et al., 1978). The last United States National Health Survey (NCHS, 1976) revealed that the most common impairments (over 20 million) involved the musculoskeletal system. About one fifth of these were classified as "synovitis, bursitis, or tenosynovitis" — disorders frequently associated with job tasks which impose cumulative "micro" traumas to the musculoskeletal system. In 1981, the Bureau of Labor Statistics reported over 23,000 cases of repetitive trauma disorders, with an estimated 270,000 lost work days (Personal communication with Bureau of Labor, 1981). One way to prevent work-related disorders of the musculoskeletal system is through the application of the principles of ergonomics.

DEFINITION AND GOALS

The word ergonomics comes from the Greek word *ergo,* meaning work and *nomos,* meaning law. It is a discipline which recognizes the physiological, anatomical, and psychological capabilities and limitations of people, with respect to their work tasks, equipment used, and the job environment. The goal of ergonomics is to establish a best fit between the human and imposed job conditions to ensure and enhance worker health, safety, and comfort as well as productivity. This paper discusses how to perform an ergonomic evaluation within the framework of the nursing process. The focus is on the prevention and control of the two major categories of occupational health problems affecting the musculoskeletal and peripheral nervous system. The first of these, upper extremity cumulative trauma disorders (CTDs), is associated with repetitive, forceful hand/wrist movements; the second is muscle strain and fatigue, resulting from static muscular work.

Cumulative Trauma Disorders: Cumulative trauma disorders of the upper extremities are associated with repetitive exertions. Movements such as wrist extension and flexion and ulnar and radial deviation of the wrist are examples of postures which can affect the hand/wrist system. Many work-related CTDs involving this part of the body have been reported and include tendonitis, tenosynovitis, bursitis, trigger finger, and epicondylitis (Armstrong, Foulke, Joseph, & Goldstein, 1982). Those affecting the peripheral nervous system include carpal tunnel syndrome, cubital tunnel syndrome, ulnar notch syndrome, thoracic outlet syndrome, radial nerve entrapment and digital neuritis. Each of these disorders has its own set of symptoms (Feldman, Goldman & Keyserling, 1983), but a common feature to all is that they develop gradually as a result of cumulative micro-traumas rather than due to an acute macro-traumatic episode. In an occupational setting, associated risk factors include repetitiveness (frequency), and force required of a task, posture, and use of hand tools.

Muscle Strain and Fatigue: Muscular activity can be classified as either dynamic or static work. In dynamic work the muscle alternately tenses and relaxes providing a pumping action which promotes the circulation of blood. During dynamic work a muscle receives necessary nutrients and rids itself of painful waste products. By comparison, prolonged contraction of a muscle such as occurs during static work leads to a rise in pressure in the contracted muscle which compresses blood vessels and restricts blood flow to the tissue. During

static work not only does the muscle receive insufficient nutrients but waste products accumulate as well. Moreover, static work, if prolonged and excessive, can eventually lead to deterioration of joints, tendons, and ligaments (Grandjean, 1980). Some examples of static postures are flexion or abduction of the arms or shoulders, leaning forward or sideways, placing body weight on one leg, pushing and pulling, crouching or crawling, and working with a bent or twisted neck or spine (Grandjean, 1980; Van Cott & Kinkade, 1972). Static muscular activity is often responsible for nonspecific aches and pains as well as muscular fatigue and can result in reduced productivity and absenteeism. Work postures which cause static loading of muscles should be avoided.

PREVENTION OF ERGONOMIC HEALTH PROBLEMS

The nurse is a vital part of the interdisciplinary occupational health team, a team which may also include the physician, industrial hygienist, and safety or industrial engineer. These other members of the team are valuable resources who can help the nurse plan and carry out prevention/control programs. As a member of this team, the nurse who has a health promotion background, is in a unique position to use the nursing process to recognize, evaluate, prevent and/or control occupational ergonomic hazards. Indeed, the nurse more than any other member has the opportunity and responsibility to regularly see every individual in the workforce. Accessibility, visibility, and ability to communicate with employees are essential.

In the next sections, ways in which the nurse can use basic ergonomic principles with the four components of the nursing process — Assessment, Planning, Implementation, and Evaluation — to improve the work environment are presented.

HAZARD IDENTIFICATION

The nurse should assess the need for programs in health promotion, worker education, and worker/job matching. A

FIGURE

A SAMPLE ERGONOMIC CHECKLIST TO IDENTIFY POTENTIAL HAZARDS IN THE WORKPLACE

- General Work Environment
  - Workforce characteristics
    - Age, sex, anthropometrics (body size and proportions)
    - Strength, endurance, fitness
    - Disabilities
    - Diminished senses
    - Communication/language problems (e.g., non-English speaking or illiterate workers)
  - Lighting
  - Climate
  - Noise Level
  - Health and safety safeguards

- Job and Workstation Design
  - Location of controls, displays, equipment, stock
    - Accessibility
    - Visibility
    - Legibility
    - Efficiency of sequence of movements when operating or using
    - Use of pedals
    - Posture of workers
      - Sitting, standing, combination
      - Possibility for variation
      - Stooping, twisting or bending of the spine
    - Chair availability, adjustments
    - Room to move about
    - Work surface height
  - Predominately dynamic or static work
    - Alternation possible
    - Use of devices such as clamps or jigs to avoid static work
    - Availability of supports for arms, elbows, hands, back, feet

- Muscular Work Load/Task Demands
  - Repetitiveness
    - Frequency
    - Force
    - Availability of rest pauses
    - Possibility for alternative work
    - Skill, vigilance, perception demands
    - Efficiency of organization (supplies, equipment)
  - Use of hand tools
    - Hand and wrist posture during use
    - Work surface height
    - Size and weight of tool
    - Necessity, availability of supports
    - Shape, dimensions, and surface of hand grip
    - Vibratory or non-vibratory

- Physical strength requirements
  - Strength capabilities of employee
  - Working pulses/respiratory rate
  - Loads lifted, carried, pushed, or pulled
    - Manner in which handled
    - Weight and dimensions of objects handled

plant profile detailing the general work environment, workforce characteristics, the type of work performed, e.g., task demands, and potential for hazards to the health and safety of workers should be developed.

Information may be obtained by making plant rounds or "walk-throughs," observing work practices, postures, and tools, and talking with workers. Being a contributing member of the safety committee is important. Other sources of data include health and personnel records, insurance claims and payments, workers' compensation records, illness and absenteeism logs, and the OSHA log. The nurse, as a member of the occupational health team, should evaluate the workplace for potential hazards to the health and safety of employees. A list of items to consider in an ergonomic evaluation is presented in the Figure. Several detailed "ergonomic checklists" with examples showing how to use them are available in the literature (Grandjean, 1980; Konz, 1979; Webb, 1982).

As part of the assessment phase an ongoing surveillance program should be established in the workplace. The nurse should look for clusters of similar disorders or symptoms, and these findings should be categorized by person, place, and time. Consideration should be given to who is affected: his or her age, sex, and job classification; where the "cases" are occurring, i.e., in a particular building, department, or line; and when these "cases" occur. Are they cyclic? Has there been a recent increase, associated with the introduction of a new piece of equipment such as an air-powered hand tool? Do they occur on a certain shift? Have there been other recent changes in job activity such as a change in production rate or type of product produced? Incidence and/or prevalence rates should be calculated and documented to identify high-risk areas or groups, and to evaluate the effectiveness of intervention procedures.

PREVENTION

Based on the results of the assessment phase, the nurse can develop a plan of action. Resources from both within and outside the work setting should be determined. Other members of the health team such as the safety professional or industrial engineer may need to be consulted. The industrial engineer, for example, may be called upon to perform a job analysis which is a breakdown of a task into its basic elements. If these elements are related to stressful hand and wrist motions, such as extreme wrist flexion or extension which are associated with the development of carpal tunnel syndrome, the engineer may recommend a change in hand tool or job design to minimize these stressors.

Management cooperation and support is essential if any program is to succeed. One way to obtain this support is to perform a cost/benefit analysis to document the need for a control program (Hymovich & Lindholm, 1966; Lublin, 1983; NIOSH, 1980) and present it to management. Important considerations are workers' compensation and other insurance claim payments and costs associated with lost work days and decreased productivity. During this phase, the nurse should develop a plan and work with supervisors and the personnel department to reassign employees returning to work after surgery, injury, or illness. Here, surveillance data could be used to determine appropriate alternate jobs for such workers. The nurse should be involved in developing worker/job matching strategies, employee training/education programs, and/or health promotion programs.

EVALUATION

Lastly, any interventions or programs which were instituted must be evaluated to determine if the program is effective. If a tool or workplace modification was implemented, for example, another job analysis may have to be performed to ensure that the control measures have successfully eliminated stressful work postures. All outcomes should be noted and documented. This would include changes in the incidence or prevalence rates of illness, injury, and absenteeism. Other less direct indicators would include information on the number and type of job transfers, changes in productivity, and, if possible, any indications of changes in employee morale or job satisfaction.

SUMMARY

The nurse is in a unique position to recognize, evaluate, and control ergonomic hazards and to act as a catalyst and coordinator to prevent them. The ability to perform the basic nursing functions of promoting health and preventing illness and injury will be enhanced with a knowledge and the application of the principles of ergonomics. The nurse can make a difference!

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