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Successful Management of Musculoskeletal Disorders

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ABSTRACT

A National Academy of Sciences study found that musculoskeletal disorders of the back and arm are an important national health problem with over 1,000,000 workers missing time from their job each year, at a cost of over $50 billion a year. When one takes indirect costs such as reduced productivity, loss of customers due to errors made by replacement workers and regulatory compliance into account, estimates place the total yearly cost of all workplace injuries at well over $1 trillion or 10% of United States Gross Domestic Product. Debates regarding causation and subsequent financial responsibility have delayed the opportunity to provide effective prevention in the workplace. Effective prevention of workplace illnesses (musculoskeletal disorders) through active intervention is not only possible, but results in significant costs savings for the employer while reducing the disability experienced by the individual employee.

Key Words: occupational, injury, illness, risk assessment, workplace.

INTRODUCTION

On July 17, 2001, Labor Secretary Elaine Chao opened the first of three public forums with the comments:

> We can choose to do one of two things starting today. We can play politics or we can protect workers. We can engage in sideshows or we can pursue safety, but the goal is to answer the following three questions. 1. What is an ergonomics injury? 2. How can the Occupational Safety and Health Administration, employers and employees determine whether an ergonomics injury was caused by work-related activities or non-work-related activities; and, if the ergonomics injury was caused by a combination of the two, what is the appropriate response? 3. What are the

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most useful and cost-effective types of government involvement to address workplace ergonomics injuries?

This question demonstrates a fundamental misconception about ergonomics. There is no such thing as an "ergonomics injury." Ergonomics is an applied, design-oriented science that can assist companies in reducing the occurrence of what OSHA has termed "musculoskeletal disorders" (MSDs). Applying ergonomics principles is a method through which MSDs and their direct and indirect costs can be controlled. Ergonomics can also be applied to increase productivity and efficiency, reduce errors, improve quality, reduce waste, increase employee retention and satisfaction and ultimately improve work, products and a company's bottom-line.

So, rephrasing the question for accuracy, we respectfully suggest, "What is an ergonomics injury?" be rephrased as "What is an MSD?" MSDs are illnesses or disorders of the muscles, nerves, tendons, ligaments, joints, cartilage and spinal discs. Although commonly called injuries, OSHA has defined an injury as occurring from a single event while illness occurs over time. MSDs can be directly and indirectly related to risk factors associated with activities and environment in the workplace and in the nonworkplace. Examples may include forceful exertions, awkward postures, repetitive exertions and exposure to environmental factors like extreme heat, cold, or vibration. It is often a combination of these risk factors that, over time, may lead to pain, injury, illness and disability.

This physiological model is based on an event such as lifting, pushing, or pulling, which may stress body tissues, yet the exposure may be too low for traumatic injury and the tissues recover. Some individuals have greater capacity to tolerate physical activity (individual risk). Repeated exposure to this stress, on the other hand, may interfere with the normal recovery process and produce disproportionate responses and eventually an MSD event. Traumatic injuries may occur due to cumulative effects that manifest themselves suddenly at the time of a specific event, or they may occur because the event exposes the body to risk factors that exceed the person's individual capabilities. A sudden back or shoulder injury tied to a specific task is an example.

When an MSD is associated with work it is usually referred to as a Work Related Musculoskeletal Disorder (WRMSD or WMSD). Other terms, such as cumulative trauma disorder (CTD), repetitive stress injury (RSI) and repetitive motion injury (RMI), mean roughly the same thing as MSD. However, RSI and RMI are arguably inaccurate because these terms imply that repetition is the primary risk factor, which may or may not be the case. Further, MSDs are not a medical diagnosis but a descriptive term for musculoskeletal pain.

This paper is designed to review successful examples of prevention and management of MSDs in the workplace using an individual and job risk assessment instrument. With these examples, we hope to show that ergonomics is not the problem, but is part of the solution for the questions asked by Labor Secretary Chao.

Risk Assessment

Although the concept of MSDs prevention is appealing, a limiting factor has been the lack of an appropriate risk assessment instrument that combines the risk for the individual and the job to provide prioritization for engineering controls. For the risk assessment instrument to be effective, it must meet certain criteria that include: reliability, reproducibility of results, internal consistency, validity and sensitivity (Amadio 1993; Bergner and Rothman 1987; Franzblau *et al.* 1997; Guyatt *et al.* 1987; Guyatt *et al.* 1992). This paper will discuss successful management of MSDs in the workplace using a musculoskeletal disorders (MSDs) specific assessment instrument that includes upper and lower extremities and the back. This risk assessment instrument provides a risk for the individual based on age, gender, inherited genetic characteristics, biosocial issues **and** nonworkplace activities (Melhorn 1996a,c; Melhorn 1998a,d; Melhorn *et al.* 2001; NAS 1999; NRC 1998) and a separate risk scale for job factors that includes input (raw materials), production (methods, materials, machines, environment, physical stressors) **and** output (finished product) (Melhorn 1998b). Since MSDs require an individual in a job, separate assessment instruments have been developed that can be combined for a composite risk from 1 (lowest) and 7 (highest) to assist in management protocols. Individual risk is established by 79 questions and 24 physical measures (Melhorn 1996b). While the job risk has 85 questions and was established by using a modified rapid upper limb assessment instrument (McAtamney and Corlett 1993; Melhorn 2001). Each instrument assigns a relative value to a question and all questions are then combined to provide a summary risk. These two assessment instruments have been previously published and will be referred to as a risk assessment instrument in the remainder of this paper (Melhorn 1996b; Melhorn 2000).

Successful Ergonomic Programs

The General Accounting Office and NIOSH list six critical elements necessary for successful ergonomics in the workplace (Cohen *et al.* 1997; GAO 1997). Using these six critical elements (management commitment; employee involvement; risk assessment of individual and job; analysis of data and development of controls; training and education; and traditional health care management) successful ergonomics intervention programs were developed. Individuals are unique, as are employers; however, successful management of MSDs can be accomplished using the same risk assessment instrument. The following examples will suggest opportunities for other employers.

Impact of Workplace Screening

A prospective study of the impact of workplace screening was undertaken in 1997 by a financial institution with 82 employees assigned to six branch offices. Data were collected for age, gender, job, branch local **and** study group (control or screened). The control group was made up of individual employees who received no information regarding the study or MSDs in the workplace. The study (screened) group was introduced to MSDs in the workplace by an office memo, employee management meetings, educational materials **and** a question and answer session over a four-week period followed by 40 of the employees being screened using an assessment instrument (screened group) (Melhorn 1996b).

The screened group was further randomly divided into a group of 20 individuals who were informed of their risk assessment score and 20 who were not informed.

Individuals were notified or informed of their individual risk level by letter and a follow-up interview. Education was provided to the informed group but no specific health interventions, workplace modification, or ergonomic programs were provided. Retrospective data was collected for the 5 years before the start of this study. During the study period, the employer experienced the usual first aid events and workplace injuries, but no OSHA 200 “F” injures (MSDs). **Conclusions:** Employers may be concerned with workplace screening, however this study suggests that the impact to the recordable rate may be minimal.

Tools and Ergonomic Program Design

In a prospective study, 212 workers were randomly sampled out of an 8000-member workforce for musculoskeletal disorders or activity induced pain in the workplace with activities (Melhorn 1996b). Employees were randomly assigned to one of four primary groups: vibration-damped rivet guns, standard rivet guns (control group), ergonomic training and exercise training (Melhorn 1996a). Individual risk assessment was performed at the start of the study and at 7 and 15 months.

A statistical model was developed that included the following controlled variables: (job, rivet gun, posture, time, **and** exercises) and uncontrolled variables (task specific measures such as number of rivets driven, number of rivets bucked, number of holes drilled). Ergonomics training included awareness of early warning signs of musculoskeletal disorders, methods for controlling risk factors, techniques to apply forces with less stress or strain **and** correct posture to improve balance and absorb forces. Exercise training included muscle relaxation and gentle stretching of muscles and tendons. Tool options included vibration dampening rivet (recoilless) gun, standard rivet gun, conventional bucking bars **and** training for specific tool use.

Analysis demonstrated benefits for the individual, which included fewer musculoskeletal pain events, a reduction in pain severity of the pain **and** a reduction in number of days with pain. Employer benefits included fewer OSHA 200 log events, a reduction in lost work time, a reduction in restricted workdays **and** a reduction in workers’ compensation costs. Ergonomics training had a statistically significant impact on the preceding benefits and resulted in a reduction of individual risk as measured by the risk assessment instrument. Additional reduction of risk occurred with ergonomic training and the covariates of dominant hand, time spent in an awkward position **and** number of standard rivets bucked. Exercise training demonstrated a risk reduction benefit for the covariates of dominant hand, number of parts routed **and** number of parts ground. Vibration dampening riveting provided risk reduction for new employees, but increased risk for current employees. **Conclusions:** Employees benefited from ergonomic and exercise training with a reduction in MSDs and employer estimated savings was $4 million based on cost of purchasing vibration dampening rivet guns for all employees. For every dollar spent on prevention, the employer saved $285 (a benefit to cost ratio of 285) for direct workers’ compensation costs. **Observations:** The increased risk for current employees using the new tool (vibration dampening rivet gun) appears to be due to a change in the tactile feedback of the rivet gun. After using a specific rivet tool for years, each employee had developed a feel for when to stop riveting, but with the new tool, the feeling was lost and a subsequent increase in the time, frequency and duration of riveting occurred. New employees having no previous experience with the feedback were able to learn the correct approach using the new tool.

Workplace Intervention Program

In a prospective study, a plastic products manufacturer wanted to improve their safety program by identifying individuals and jobs at risk (Melhorn 1997b). All jobs were analyzed for workplace risk factors (methods, materials, machines, environment, and physical stressors) and were prioritized for interventions based on job and individual risk. The ergonomics team (which consisted of an employee representative, supervisor, ergonomists, safety engineer, health nurse and physician) reviewed higher risk jobs (Melhorn *et al.* 1999a). Job modifications included administrative controls, work practice modification, personal protective equipment, retrofit engineering and informed purchasing. When new product lines were developed, workplace design was part of the initial consideration based on the benefits of previous job modifications and job risk reduction, as measured by the risk assessment instrument. Individual intervention included education, exercise and job training.

Quarterly analysis showed a reduction in the OSHA 200 incidence rate, lost time workday severity index and workers' compensation costs while production increased and rework decreased. Over 24 months, the combined composite risk score from the instrument for the company moved from 4.79 to 3.95. **Conclusions:** A risk assessment instrument can be used to identify job risk, to prioritize job modification by an ergonomic team and to identify individual risk for development of personalized intervention programs based on education, exercise and job training. This combined approach provided the employer with reduced costs of $234,000 for year 1 and $953,000 for year 2 when compared to the previous two years. The benefit to cost ratio was 185 for the intervention program without consideration of the increased production. **Observations:** Individual and job risk assessment resulting resulted in effective distribution of limited funds that were available for this prevention program.

MSD Prevention for New Hires

A prospective study with historical data for comparison was completed for an aircraft manufacturer using an assessment instrument (Melhorn 1996b; Melhorn 1997b,c; Melhorn and Wilkinson 1996). During a 2-year period, 1010 new employees were hired. The company elected to risk-assess individuals for the high risk job of sheet metal mechanic (n = 754) and not to risk assess individuals for the low risk job of administrative staff (n = 256), which served as the control group. After a conditional job offer, each individual was seen by the company physician for functional capacity assessment, which included a traditional employment examination and, laboratory testing. Risk assessment was provided for the high-risk job group only. The individual risk assessment scores were used to help the physician develop individual specific education and exercise programs. Education included review of ergonomics in the workplace, proper lifting, body mechanics and early reporting of MSD symptoms and signs. Exercises included strengthening and flexibility programs to develop endurance, similar to the concept of spring training in baseball. Job matching was not a part of this study, as all individuals were hired for a specific job title. No intervention was provided for the control group.

Analysis of outcome measures showed a reduction in lost work hours from 3000 to 1000 and 1000 to 650 in years one and two compared to 780 to 782 and 782 to 791 in the control group. Over the 2-year study period, the number of surgeries in the study group was reduced from 14 per 754 (1.9%) to 1 per 754 (0.1%) compared with the control group with 3 per 256 (1.1%) to 2 per 256 (0.78%).

Conclusions: Individuals bring a unique risk for the development of MSDs to the workplace. Although the job may act as a trigger event for an MSD, intervention will require an approach that also takes into account the individual. Interesting observations included that individuals who are now performing the "high-risk job" have a lower rate of surgery, 0.1% vs. 0.78% and a lower lost work hours to employee ratio, 0.8 ratio versus 3.1. When considering the reduction in lost work hours and the direct costs of workers' compensation, the employer estimated savings of $1.8 million for the 2-year period with a benefit to cost ratio of over 257 for the program. The data seemed to suggest that additional benefits could be obtained by adding job risk to the new hire placement process.

MSD Prevention in New Hires Modified by Job Requirements

In January of 1995, an aircraft company established a prospective MSDs risk management program for new hires. The MSDs intervention program was designed to integrate a traditional occupational medicine clinic (physician on site) and a risk assessment instrument for assigning risk and implementing intervention (Melhorn *et al.* 1999b). The MSDs intervention program was designed to prospectively evaluate each new employee for his or her individual risk of developing MSDs in the workplace and assist the physician in matching the employee to the most appropriate available job. The concept of best fit (the goal of ergonomics) was being placed into practical application. Since these employees were being hired for many different jobs, each job was risk assessed and an essential functions description was developed. The physician used an algorithm based on individual risk score and provided transitional work options, long-term work guides, education and exercise programs. Before job placement, individuals at higher risk were assigned to a period of transitional work.

Analysis of six outcome measures were reviewed (recordable case incidence rate, lost time case incidence rate, lost time day severity incidence rate, airplane production, costs of intervention program and estimated workers' compensation costs). All rates were converted to 200,000 hours worked per year to allow comparison with other publications. There was no significant change in recordable case incidence, a significant reduction in lost time and lost time day severity incidence rate and no change in airplane production. Risk intervention costs over 4 years were: $122,928 for 3152 assessments, $29,697 for 761 repeat assessments, $142,500 for transitional work (production loss), $2028 for education and $7485 for administration with a total of $304,470 or $76,118 per year which represented less that than 0.06% of the employer's annual salary costs. Workers' compensation cost decreases per year were: 16%, 3%, 24% and 12%, while work hours increased 56%. Employer-estimated savings in direct workers' compensation costs per year were $469,990, $678,337, $1,936,105 and $1,995,759 during a time when the total hours worked doubled with a benefit to cost ratio of over 390% for the program.

Conclusions: New hire MSDs management can be improved by including the risk associated with the future job activities. After a period of transitional work, most employees will not require permanent work guides. This will become increasingly important as the national workforce ages and more individuals with disabilities are employed. Observation: Only 11 of the 34 (29%) with risk scores of 7 required permanent restrictions as follows: vibratory or power tool was limited to 6 of 8 hours in time blocks of 1Ω hours per 2 hours and repetitive motion tasks were limited to 6 of 8 hours in time blocks of 50 to 55 minutes per hour. This group represents less than 1% of the original high-risk group (risk scores 5 to 7, n = 761) and only 0.4% of the entire study group.

Medical Management Current Employees

In 1998, an aircraft company modified their medical intervention protocol to include the use of an individual risk assessment instrument to assist in the decision of medical referral after retrospectively reviewing the previous two years workers' compensation records. A decision was made to address medical management of MSDs seen by health services. A prospective study was developed with a specific decision tree for all employees that reported to health services with a recordable OSHA 200 MSD event. The company physician evaluated each employee using traditional healthcare techniques and the completion of the risk assessment instrument. After completing the history and physical examination, the physician would review the current and previous individual risk score. If either individual risk score was above average (5, 6, 7>4), the employee was referred to a specialist for additional treatment. If the individual's risk score was below average or average (1, 2, 3, <4) in-house medical care was provided.

Analysis of ten outcome measures was reviewed (recordable case incidence rate, lost time case incidence rate, lost time day severity incidence rate, airplane production, costs of intervention program, estimated workers' compensation costs, number of operations, medical treatment and job activities, or new tasks). Improvements in incidence rates and production occurred with reduction in costs, surgery and treatment. New tasks and onset of symptoms were reviewed. Over 70% of low risk individuals and none of the high-risk individuals had experienced a job change or new task in the previous 6 weeks prior to onset of symptoms. **Conclusions:** Traditional medical management of MSDs can be enhanced by using a risk assessment instrument. Employer-estimated savings in direct workers compensation costs were $2.42 million and estimated indirect savings were more than $13.5 million during the study with a benefit to cost ratio (or direct costs only) of over 398% for the program. **Observations:** Individual risk scores of 6 and 7 did not require a change in job or a new task to trigger an MSD event. As the individual risk score decreases the job requirements or task change increases. The data suggests a ratio of individual to job risk of 65 to 35 for predicting the likelihood of any one individual for developing an MSD. This ratio is being further evaluated in current studies to assist in better allocation of intervention funds in an effort to reduce risk and incidence.

SUMMARY

Successful management of occupational musculoskeletal problems goes beyond the traditional medical dimension. Despite the continuing debate on causation, current medical and epidemiological literature support a relationship between activities and musculoskeletal pain. Reasonable management decisions can be made based on individual and job risk provided by assessment instruments (ACOEM 1997; Day 1988; Gordon *et al.* 1995; Herington and Morse 1995; Melhorn 1997a; Melhorn 1998a). The benefit to cost ratio of interventions can be over 300 for MSD programs (Melhorn 1996a; Melhorn 1998a,c; Melhorn 1999). Financial and legislative initiatives will mandate prevention from a public health perspective (Baker *et al.* 1988; NIOSH 1999). Prevention by risk assessment currently provides another opportunity for reduction of the incidence and severity of work-related musculoskeletal disorders by allowing engineering controls to be applied in a prioritized approach, resulting in real solutions for the problems facing the American worker.

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