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ACCIDENT REDUCTION THROUGH STRESS MANAGEMENT

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ABSTRACT: The deleterious effects of occupational stress on worker health and well-being have been described in numerous reports for a wide range of work groups. Work overload (and underload), deadline pressures, role stressors, underutilization of abilities, and physical discomfort have been identified as work factors associated with increased stress symptom reporting. The relationship between work stress and accident/injury occurrences is less clearly documented, although scattered reports in the literature suggest a contributory role for stress in the accident process. In this article, data linking stress to unsafe work behavior are reviewed and a model is proposed wherein accidents can arise from impaired worker capabilities (e.g., slower reaction time) brought about by stress symptom activity (e.g., anxiety). The potential usefulness of stress management training (SMT) for shortcircuiting the stress/accidents cycle by alleviating stress symptoms is discussed in light of recent empirical research.

Stress is pervasive and can affect diverse areas of human functioning. Undue levels of stress can alter one's mood state, perceptions, performance, and thinking processes in addition to biochemical and physiological functions (Benson, 1976; Cooper & Payne, 1978; Selye, 1976; Murphy &

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Hurrell, in press). With such an array of consequences, it would not be surprising to discover that stress plays a contributing role in workplace accidents. Although empirical evidence does not firmly document this expected relationship, scattered reports in the literature suggest a role for stress in the accident process.

The purpose of this article is two-fold. The first purpose is to review research dealing with job stress/health relationships and accident causation. Based upon this review, a heuristic model is offered wherein stress symptom activity produces decrements in worker capabilities, thereby increasing accident risk. The basic premise of the model is that a percentage of all accidents are a function of temporary, unsafe behaviors brought about by stressor-induced disorganization of workers' capacities. The second purpose of the article is to examine the usefulness of worksite stress management training (SMT) for reducing stress symptoms and, to the extent, accident risk.

HEALTH AND SAFETY ASPECTS OF JOB STRESS

Over the past 10–15 years, the knowledge base on occupational stress has increased substantially. Job elements of work overload (and underload), deadline pressures, role stressors, underutilization of abilities, and physical discomfort have been shown to be associated with worker distress and job dissatisfaction (Caplan, Cobb, French, Van Harrison, & Pinneau, 1975; Cooper & Payne, 1978). Work routines such as shiftwork and machine-pacing have also emerged as risk factors (Murphy & Hurrell, 1980; Tasto, Colligan, Skjei, & Polly, 1978). Health complaints associated with such stressors have included acute reactions (e.g., headaches, stomach distress, muscle/joint complaints, and negative mood states) as well as more chronic health outcomes such as coronary heart disease and mental ill health (Cooper & Marshall, 1976; Hurrell & Colligan, 1982; Selye, 1976.)

Along with this increase in knowledge has come a realization of the complex nature of job stress/health relationships. Figure 1 shows a model that incorporates much of what is known in this area. The core of the model shows, via the bold arrows, that job stressors can lead to acute reactions reflecting psychological, physiological, and behavioral dysfunctions. These, in turn, can lead to chronic health conditions such as coronary heart disease and mental ill health.

The relationship, however, is not this straightforward. As depicted in Figure 1, *Nonwork Factors* and *Individual Factors* each play a dual role. On the one hand, financial or family problems can exacerbate existing job stressors to promote acute stress reactions. Alternatively, the absence of such extraorganizational problems (e.g., low overall life stress) can make a less-than-satisfactory job situation more tolerable (less stressful) and can impede the development of stress reactions. A similar relationship could

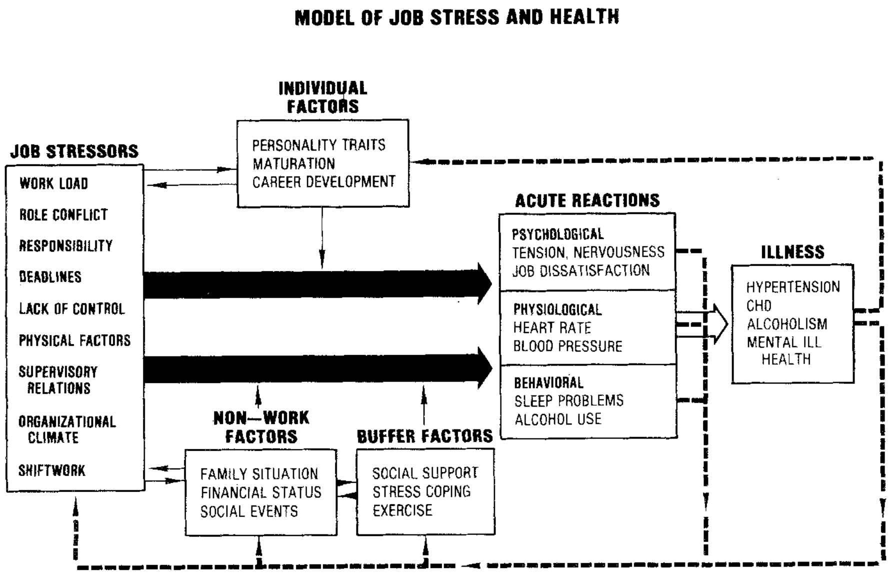

Figure 1. Model of occupational stress and health.

be sketched for *Individual Factors*. Overall, these factors can: (1) influence the perception of job characteristics in a positive or negative way; and (2) impede or promote stress reactions.

Buffer Factors such as social support and stress coping skills function to weaken the stressor/acute reaction link and reduce the occurrence of ill health outcomes. Moreover, the presence of stress symptoms or chronic health conditions feedback (shown as dotted line) to different points in the model to intensify the cycle. Overlaying a "time" factor on the entire model (as suggested by Newman & Beehr, 1979) and adding a person–environment fit dimension (Caplan et al., 1975) further heighten the complexity of the research problem.

Orme-Johnson (1986) has begun to cost out the impact of stress coping skills training on the reduction of stress-related disease and health-care insurance costs. In a 4-year cross-sectional study of 1,800 regular practitioners of the Transcendental Meditation Program versus 22,440 members of a heterogeneous business group, the meditators had half the total health insurance costs across multiple criteria (e.g., hospital admissions, length of stay, cost of treatment). The two groups were matched on major demographic variables. These findings are consistent with earlier cost benefit analyses and support the notion that stress management training can save companies money.

Job Stress and Safety

In contrast to the burgeoning literature on the health consequences of stress, little research attention has been directed toward identifying the safety consequences of stress. The magnitude and seriousness of the problem of workplace accidents need not be thoroughly reviewed here. It is sufficient to appreciate that in 1983, workplace accidents resulted in 11,300 deaths and 1.9 million disabling injuries, and cost this nation an estimated 33.4 billion dollars (National Safety Council, 1984).

Accidents and their antecedent conditions have traditionally been examined using two different approaches: (1) engineering-based and (2) employee-based (Heinrich, 1931). The engineering approach emphasizes *unsafe conditions* in the work environment as major causes of accidents and focuses on designing safety hazards out of the job. The employee-based approach views *unsafe acts* as the primary cause of accidents and seeks to improve the safety performance of workers as an accident prevention strategy. Although it is convenient conceptually to dichotomize these approaches, in practice it is not a clean split. The approaches are not mutually exclusive and elements of each contribute to improving safety in the workplace. However, we will be focusing on employee factors in this article.

An early employee-centered approach keyed on accident repeaters, seeking to identify an accident-prone personality. Accident proneness was believed to be an enduring trait of some workers, which increased their likelihood of being involved in an accident. Characteristics of the accident-prone individual included lack of awareness of potential hazards, excitability of temperment, inattention, psychomotor retardation, and low intellect (Tiffin, 1942; Vitales, 1932). Although staunchly defended at one time, the current view of accident proneness is that susceptibility to accidents varies considerably from one situation to the next and is less related to worker constitutional factors (Ashford, 1976; Surrey, 1968).

The accident proneness controversy produced a significant body of literature relating psychological/behavioral factors to the accident process. While the theory itself appears untenable, the data linking psychological factors to accident occurrences remains viable.

The following section reviews some of the literature linking psychological and behavioral factors, either directly or indirectly, to performance decrements and increased risk of accidents. Three such factors will be reviewed: (1) stress/anxiety, (2) fatigue, and (3) alcohol/drug use. Some data also exists for these factors from the stress/health literature, suggesting a basis for linking stress to accident risk. Admittedly, these factors are interrelated, and may exist concurrently to exacerbate consequences.

Stress/Anxiety. Laboratory research has provided significant evidence associating stress or anxiety with performance decrements. For example, Beier (1951) reported a lessening of abstract abilities and of visual–motor coordination in persons experiencing threat-induced anxiety. Deese and Lazarus (1952) found poorer performance on a psychomotor task among Air Force enlistees faced with the treat of elimination from the service compared to a control group. Similarly, Lazarus and Erickson (1952) reported more errors on a digit-symbol task among college students faced with failure stress. Finally, in a more recent field study, Friend (1982) reported that higher levels of perceived workload and deadline pressure were associated with porer task performance among managers.

These and other studies have supported an inverted U-shaped relationship between arousal level and performance. Performance is optimal at moderate levels of arousal, but decrements become evident at very low or high levels of arousal. Conceptually, the model implies a greater potential for unsafe acts under conditions of very low or very high arousal as a function of the magnitude of intellectual and performance deficits.

In work settings, the relationship between stress and accidents is not firmly established. At the same time, studies dating back to the 1930s suggest a role for stress and emotional factors in the accident process. Heinrich (1931) believed that only about 10% of all industrial accidents were attributable to physical causes such as faulty equipment. Factors such as employee concentration, unsafe behaviors, and mental or physical unfitness for the job were offered as explanations for the remaining 90% of work accidents.

Hersey (1936) adopted a clinical approach in a study of 400 work accidents and found that over 50% took place when workers were in emotionally low states. According to Hersey, the average worker was emotionally low about 20% of the time.

Kerr (1950) noted the importance of increased worker control and participation in decision-making as factors associated with fewer industrial accidents. (It is interesting that these factors have been described as major job stressors in recent literature, e.g., Karasek, 1979). Factory departments with greater promotion potential, more intracompany transfer mobility, the best suggestion records, and higher job prestige ratings had fewer accidents (Kerr, 1950). In his review of contemporary theories of safety psychology, Kerr (1957) apportioned variance in accident rates among industrial personnel in terms of theoretical causation as follows: (1) accident proneness, 1–15%; (2) organizational policies regarding worker freedom to set their own attainable goals, 30–40%; and (3) negative, distracting stress impinging on the worker, 45–60%.

A number of studies noted the presence of emotional/stress factors operating in workers prior to or at the time of workplace accidents (see Sleight and Cook, 1974). Hirshfeld and Behan (1963), for example, found indications of heightened anxiety, depression, and low self-esteem in workers prior to an accident. Similarly, in a study conducted at the Naval

Safety Center, pilots and crew members who were involved in aircraft accidents were found to have been exposed to more stressful life changes before the accident than personnel who were not in accidents (Alkov, 1981). As noted earlier, though accident proneness is no longer considered a tenable theory, the notion of temporary accident liability due to acute stress (whether at work or not) remains a frequently mentioned causative factor in work place accidents.

Fatigue. A second factor linked to accidents is fatigue. Fatigue, like stress, can be a "fuzzy" concept and definitions abound ranging from purely psychological to purely mechanical/physiological. Grandjean (1970) views fatigue as a generalized response to stress defined operationally as a decreased attention span, slower reaction time, lower motivation, impaired thinking, and decreased psychomotor performance.

The relationship of fatigue to accidents is more clearly demonstrated in the auto accident literature (e.g., Harris & MacKie, 1972). Less evidence supports the linkage in work settings. Regarding the later, Hale and Hale (1971) cite the following evidence: (1) More accidents occur during peak production periods when fatigue is presumed to be high; (2) Accident rates for older workers are disproportionately high when the work shift is increased by 30 minutes; and (3) Accident rates tend to be higher just before breaks compared to just after breaks, again when fatigue is presumably higher. Also, a recent study found more accidents among nurses on rotation shifts who also reported more fatigue and sleep disturbances relative to day shift workers (Smith, Colligan, Frockt, & Tasto, 1982).

According to Bartley (1965), conflict situations, emotional upset, sleep loss, alcohol hangover, and frequent shift rotations all function to generate fatigue over and above environmental and task dependent factors. To ameliorate fatigue, McFarland (1971) recommends adequate sleep, elimination of stressful or anxiety-producing routines, physical exercise, and wise use of medication. Some of these factors have been assessed as benefits of worksite stress management training and will be reviewed in more detail later.

Alcohol Use. A great deal of evidence exists associating auto traffic accidents with alcohol use (Drew, Calhoun, & Long, 1959; Hale & Hale, 1971; Sleight & Cook, 1974). Alcohol is related to more frequent accidents, more serious accidents, and higher mortality (Metz & Marcoux, 1960). The deleterious effects of alcohol are due to its effects on vision, judgement, reasoning, memory, and psychomotor performance. One report described significant disruptive effects of alcohol on reaction time, motor performance, sensory skills, and mood state as long as 18 hours after ingestion (Tichauer & Wolkenberg, 1972).

As was true in preceding sections of this article, the industrial accident literature contains fewer citations implicating alcohol as a contributing factor to accidents, but this may reflect inadequacies in the accident investigation process. Surrey (1968) noted two French studies indicating that alcohol was involved in 10% of all industrial accidents and in 29% of those for which hospitalization was required. Demone and Kasey (1966) stated that the frequency and seriousness of industrial accidents and the mean number of days lost per accident were greater among alcoholic versus nonalcoholic workers.

In clinical practice, alcohol is viewed as a coping mechanism for emotional turmoil or stress. Alcohol is associated with a lessening of inhibitions reflected by increased sociability and apparent self-confidence. Alcohol impairs intellectual and perceptual function manifested in physical incoordination, slow reaction time, blurred vision, and faulty judgements. Often, problem drinking is a psychiatric problem growing out of tension, anxiety, and frustration. One major theory holds that tension reduction is a significant initial stimulus for drinking alcohol to excess (Williams, Calhoun, & Ackhoff, 1982).

Alcohol also interacts synergistically with other drugs and industrial chemicals, creating performance deficits larger than expected for either alcohol or drugs/chemical alone (e.g., Poulton, 1970). Major tranquilizers used in the treatment of clinical anxiety and depression can react with alcohol to produce unwanted side effects like muscle incoordination, a condition that may contribute to increased accident risk.

A STRESS AND ACCIDENTS MODEL

Though scattered and incomplete, the empirical evidence just reviewed suggests that stress, fatigue, and alcohol use can contribute to human error and thereby to accidents. A model is proposed linking stress to psychological, physiological, and behavioral impairment, and increased accident risk. The function of the model is to: (1) Organize diverse literatures; (2) Suggest testable hypotheses; and (3) Provide a vehicle for assessing the potential merits of stress management training.

Admittedly, such a model only accounts for a portion of unsafe acts and resultant accidents—it is not intended to represent the complete picture. Accidents are best understood as resulting from the interplay of work environment, training, and employee factors. Hazardous work conditions, organizational factors (e.g., poor management), and inadequate training each contribute to accident risk. The focus of this article and of the model, however, is on the potential role of job stress in the accident process. The model is shown in Figure 2. The more global term *stressors*, as opposed to *job stressors*, has been used in the model to reflect the contribution of both work and nonwork factors to overall stress levels. The first stage of the model depicts the effects of stressors on short-term, acute reactions.

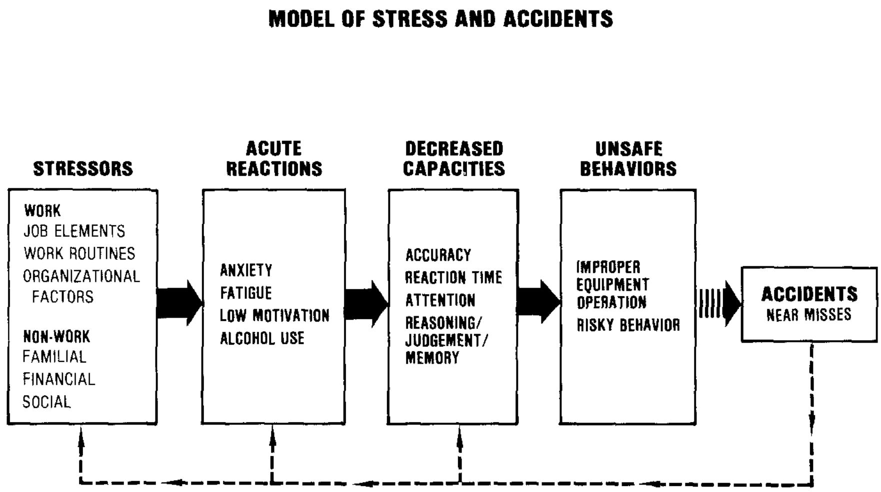

Figure 2. Model of stress and accidents.

Such reactions include psychological, physiological, and behavioral problems.

These reactions, in turn, disrupt the worker and lead to observable decreases in intellectual and performance capacities. For example, anxiety can lead to lower performance accuracy, fatigue to slower reaction time and inattention, and alcohol use to impaired judgement and reasoning. A key aspect of the model is the specification of stress reactions as the mechanism of action, which mediates the decrements in worker capabilities.

The proposed decrease in worker intellectual and performance capabilities functions to increase the probability of *Unsafe Behavior*. Therefore, *Accidents* is depicted as a probability in the model—fortunately, most unsafe behaviors do not result in accidents.

Finally, the dotted lines exiting the Accidents box in the model represent a positive feedback system whereby the occurrence of an accident itself functions as a source of stress and reactivates the cycle. The model allows for the existence of accident repeaters (or accident proneness), but the basis is high levels of stress, not personality attributes.

STRESS MANAGEMENT TRAINING

To the extent that stress contributes to accident occurrences, strategies designed to prevent or reduce stress may have potential for decreasing accident risk and find value as adjuncts to safety training programs. In this regard, a number of recent studies have evaluated prescriptive, relaxation-based methods for helping workers recognize and manage stress (Murphy, 1984a). Techniques have included biofeedback, muscle relaxation, meditation, and cognition-focused methods, many of which were borrowed from clinical practice where they have been used successfully to treat psychosomatic and psychophysiological dysfunctions (Pomerleau & Brady, 1979). As applied in work settings, these techniques have a distinct, preventive flavor with an emphasis on imparting skills to symptom-free workers. Accordingly, stress management training (SMT) is more appropriately viewed as a health-promotion activity, rather than as a treatment strategy for troubled workers.

Research has shown the efficacy of SMT for reducing reports of anxiety, depression, somatic complaints, sleep disturbances, and worker psychophysiological arousal levels (Murphy, 1984a). Most worksite SMT studies have focused on elucidating the effects of training on worker health status. Although such programs are not designed to directly influence performance or safety behaviors, the examination of such variables is necessary to document any indirect effects on employee behaviors via reduced arousal levels. For example, in two studies (Peters, 1981; Murphy, 1984b), workers reported lower alcohol intakes after SMT relative to baseline levels. Also, Kohn (1981) has shown that workers trained in progressive muscle relaxation made fewer performance errors under conditions of high noise stress than did untrained controls. These studies provide preliminary indications of the potential of SMT for influencing the accident process via reductions in stress symptoms.

The following two studies illustrate in a more direct fashion the range of benefits that can be expected from company stress management training. The first study was conducted by the National Institute of Occupational Safety and Health at a midwestern public works department employing about 300 people. Equipment accident and work injury data were obtained from organization records for 2½ years prior to and 2 years after the implementation of a 2-week stress management training program. Biofeedback and muscle relaxation training were offered to workers who volunteered for the one-time program (see Murphy, 1984a,b). Analysis of this archival data indicated no effects of training on equipment accidents but significantly fewer post-training work injuries for trained versus untrained workers ($p < .05$).

A second case study was conducted by the St. Paul Insurance Companies in a midwestern hospital that employed about 1,000 workers (DuBois, 1985). Data were gathered on the number of worker compensation claims and claim payments on a monthly basis for a 24-month period before (Phase A) and an 11-month period during (Phase B) the implementation of a number of company activities/programs that dealt with employee stress. Among these were: (1) a survey of employees focusing on organizational

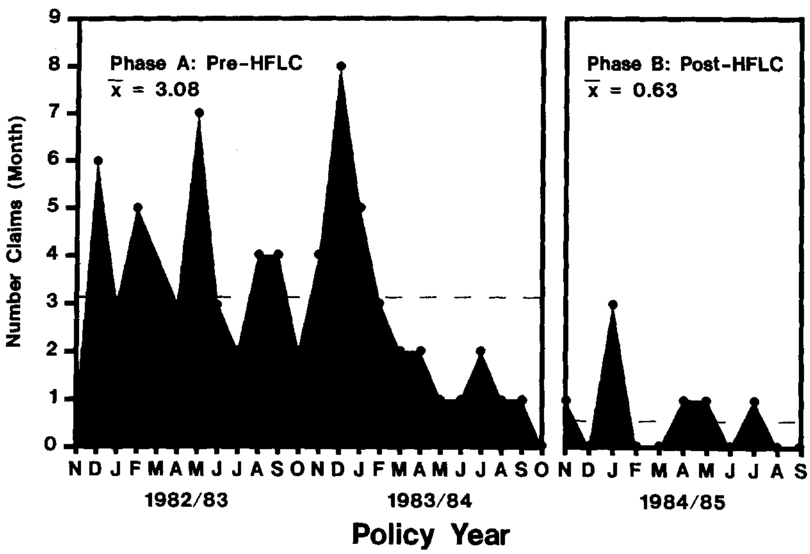

Figure 3. Average monthly worker compensation claims before (Phase A) and during (Phase B) implementation of Human Factors Loss Control (HFLC) Program.

stress; (2) a comprehensive, in-house, employee assistance program (EAP), which was made available to all employees and their families; and (3) the addition of a stress management component to an existing hospital program dealing with back injuries.

The results are shown in Figures 3 and 4. Analysis of the data indicated a significant reduction of both the number of claims ($p < .05$) and total paid losses ($p < .05$) during Phase B relative to Phase A. The average claim frequency per month during Phase A was 3.1 claims, the average monthly cost of claims was $7,329.00, and the average monthly cost of total expected claims costs was $24,199.00 By comparison, during Phase B, the comparable numbers were 0.6, $324.000, and $2,577.00. Hence, there was a significant reduction in company insurance losses per month during Phase B relative to Phase A.

SUMMARY

This article has sought to offer some linkages between occupational stress, health, and safety, and to suggest the potential value of stress management training for lowering accident risk through reduction of

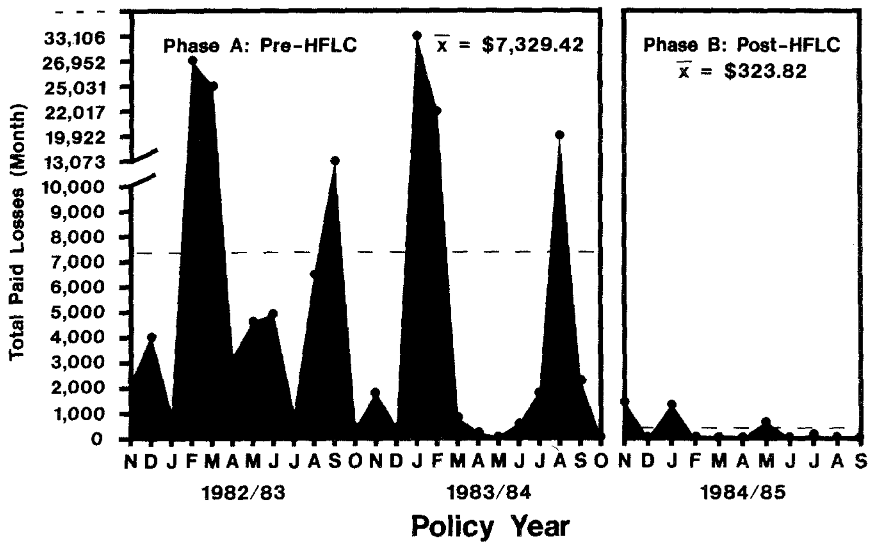

Figure 4. Average monthly paid losses before (Phase A) and during (Phase B) implementation of Human Factors Loss Control (HFLC) Program.

stress symptoms. Regarding the former, evidence was reviewed suggesting that stress may influence the accident process via decrements in worker capabilities brought about by stress symptom activity. Symptoms such as anxiety, fatigue, and alcohol use were offered as mediating factors in a stress/accidents model.

To the degree that stress contributes to accident causation, strategies designed to reduce stress might be useful adjuncts in accident prevention programs. Recent studies have shown that stress management methods can be adapted for use in work settings and appear to be effective in lowering psychophysiological arousal levels and worker reports of anxiety, fatigue, and other stress symptoms. By reducing symptoms, SMT could lower accident risk and shortcircuit the cycle. At the same time, it is reasonable to assume that strategies that seek to reduce or eliminate the sources of stress at work, such as job redesign and organizational change, would have even greater potential for reducing accident risk. Research is needed to test this hypothesis and to document the relative benefits of stress reduction and stress management strategies.

It is important, however, to place these results in the proper perspective. First, the usefulness of SMT is envisioned for a percentage of all accidents where stress plays a contributing role. What percentage this represents is not precisely known and a great deal more research is needed to determine empirically the relationship between stress and accident risk. Indeed, substantial converging evidence does not exist that links stress in a direct way to industrial accident occurrences. What little data is available suggests an indirect effect mediated by stress symptoms.

Second, no stress management studies have been designed to assess safety-related benefits. The focus of all SMT studies in the literature has been on health outcomes and improved abilities of workers to cope with stress (Murphy, 1984a). The value of SMT for reducing accident occurrences remains speculative, although this article has provided some indications of its potential efficacy. The results of the two case studies suggest the potential of stress management training for reducing employee stress and, thereby, injury risk. The data reviewed above also suggest that such programs can be cost-effective.

Admittedly, the results of the two case studies described earlier are preliminary and do not permit definitive statements of the efficacy and cost-benefit of stress management training as it affects accident risk. At the same time, the results are encouraging and warrant additional research. Taken together, the results suggest that while a one-time SMT program will have little, if any, effects on accident/injury occurrences, a more permanent, comprehensive, organization-wide program can have more substantial effects. A sustained commitment to company-wide SMT programs is expected to have the greatest impact on controlling stress-related losses. Finally, more studies are needed to confirm and expand these preliminary results to establish a better foundation for definitive statements of program efficacy. Safety-related outcome measures will have to be incorporated into future studies to assess directly the value of SMT for accident prevention. It is hoped that this article will be heuristic in this regard.

The seriousness of the problem of workplace injuries and illnesses and the resultant costs to individuals and organizations dictate an active exploration of new strategies for reducing work-related losses in functional capacity. The SMT methods described in this article have potential to become useful adjuncts to existing occupational safety training programs.

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