after a short time, 70% of individuals fail to maintain long-term commitment to exercise habits and are likely to revert to their previous lifestyle.[43]

5. In assessing the efficacy of stress-management interventions on *specific* outcomes, relaxation appears to consistently produce significant effects on some physiologic outcomes (e.g., blood pressure) and little change on other outcomes. **Cognitive-behavioral skills** training was the single intervention technique most frequently cited in stress management studies and produced the most consistent effects on psychologic outcomes, particularly anxiety. For somatic complaints, a combination of stress-management techniques appears most effective, and for job/organizational outcomes, job redesign, participatory action research, autonomous work teams, and organizational change interventions appear to be the most effective.[71,72,77,84]

6. None of the **individual stress-management interventions** were consistently effective in producing effects on job/organization-relevant outcomes such as absenteeism, turnover, accidents, health care costs, productivity, or job satisfaction. Murphy found that of individual stress-management strategies, cognitive techniques produced changes in job/organizational measures in 75% of the studies he reviewed.[71] However, in most of these studies cognitive techniques were associated primarily with subjective (e.g., job satisfaction) and not objective endpoints (e.g., absenteeism, productivity).

7. Recent findings suggest that **participatory organizational change** efforts (e.g., job redesign, participatory action research, and autonomous work teams) may be particularly effective in reducing or eliminating specific occupational stressors (e.g., job strain), and as a result, affecting both diverse individual and organizational outcome measures (e.g., productivity, blood pressure).[46,109]

Researchers have assessed the effectiveness of various stress-management interventions practiced in the workplace. Current research suggests that the effects of any one type of individual or organizational outcome typically depend on the specific stress-management technique used. Researchers and practitioners should continue to design and evaluate more comprehensive stress-management programs that attempt to change stressful aspects of the work environment as well as help individual employees learn to manage stress through improved coping. To maximize the effectiveness of occupational stress-management interventions, practitioners should attempt to integrate current findings on individual and organizational change, including readiness to change models,[87] relapse prevention,[66] transfer of training,[4] job redesign,[37] and participatory action research.[46]

HYPERTENSION: COULD LOWERING JOB STRAIN BE A THERAPEUTIC MODALITY? *by Peter Schnall, MD*

There is a well-established link between hypertension (elevated BP) and increased risk for stroke and heart disease. Indeed, recognition of rapidly rising rates of stroke and heart attack following World War II led to intensive efforts by private organizations like the American Heart Association and agencies of the U.S. government to modify known risk factors for CVD. This led, in turn, to the conduct of a number of clinical trials[2,16] that demonstrated the effectiveness of treating hypertension with medications to lower BP with consequent reduction in stroke and CVD morbidity and mortality. It is now well-established medical practice to place individuals on medication for hypertension if clinic-ascertained BPs exceed 140/90 mmHg.[25]

Unfortunately, the primary cause(s) of hypertension and CVD—which recent evidence suggests is, in part, a product of the organization and nature of work—remains neglected as potential arenas for intervention and primary prevention. In the U.S., the focus is on medical treatment of individuals with elevated BP. Given the widespread availability of effective pharmacologic and nonpharmacologic treatment for hypertension, the reader may appropriately ask, "Why should we bother with interventions aimed at preventing/reducing work-related stress and/or changing the workplace?" The following pages address this question.

Evidence that Elevations in BP Increase Risk of Stroke and Heart Disease

Evidence from epidemiological studies shows that an increase of 5 mmHg in BP has a considerable impact on stroke and heart attack rates in the general population. A meta-analysis of nine prospective studies[16] conducted among women and men concluded that a persistent elevation of 5 mmHg of diastolic BP increases the risk of strokes by 34% and the risk of coronary heart disease by 21%.[63] Furthermore, the association between daytime ambulatory BP and these endpoints is stronger than that of casual BP.[85,86]

Evidence that Treatment of Hypertension Leads to Reduction in Risk

During the past three decades, considerable evidence for the benefit of treating hypertension has been documented through a series of clinical trials beginning with the Veterans Administration Cooperative Study Group on Antihypertensive Agents in 1967.[111] Two forms of treatment for hypertension are widely available and in common use. For individuals with mild levels of BP elevation (BP ≤ 140/90 mmHg), nonpharmacologic interventions such as salt restriction, weight loss, and relaxation techniques are preferred. In the event of a nonresponse or further increase in BP despite these treatments, medications intended to lower BP are prescribed. Treatment of hypertension with antihypertensive medication generally results in BP reductions proportionate to the amount and number of medications.[1]

Limitation of Medical Treatment of Hypertension

Three serious limitations are associated with hypertension medications: issues of efficacy, side effects, and high cost. First, with respect to efficacy, there is the observation that lowering BP in clinical studies (e.g., a 10 mmHg decrease in diastolic BP from 100 mmHg to 90 mmHg) does not lower future morbidity and mortality to the same level as exists in an untreated population with BPs of 90 mmHg.[2] In addition, antihypertensive drugs are even less effective in preventing CVD than in preventing stroke.[2] Second, the greater the drug intervention, the greater the side effects experienced by the patient. These side effects not only can have a substantial, negative impact on an individual's quality of life, but can cause morbidity and mortality as well.[1,94] Third, chronic treatment is associated with substantial cost.

These limitations argue for nonpharmacologic interventions. However, while such nonpharmacologic interventions as weight loss, relaxation therapy, and salt restriction frequently are effective, they often are less so than medications and usually do not return BP to normal in individuals with sustained elevations of BP.[25] The problems with intervening exclusively on these "proximate" causes of disease and the need for a social-ecologic-public health approach are discussed on pages 245–252.

Evidence that Job Strain Is Linked to Hypertension

Several threads of evidence now link the workplace to hypertension and ultimately to CVD. Specifically, during the past two decades many studies have linked job strain to increases in ambulatory BP (amBP) and to CVD (see Chapter 2). The largest study of job strain and hypertension that uses AmBP monitoring in a longitudinal design has been the ongoing Cornell Worksite AmBP Study, which is designed to investigate the hypothesis that exposure to job strain is causally related to increases in mean AmBP.[98]

The sample consists of 285 healthy male employees, aged 30–60 at initial recruitment (Time 1), at eight New York City worksites; 195 were restudied 3 years after their initial participation (Time 2), and 194 were restudied 6 years later (Time 3). Mean systolic (S) and diastolic (D) AmBP at work, home, and during sleep were computed from 24-hour recordings and diary entries specifying location. The relationship of job strain to AmBP was examined cross-sectionally at each round of data collection. In addition, to take advantage of our information on job strain status at each assessment and to evaluate the impact of changes in exposure, a job strain change variable was constructed with four categories: those defined as having no job strain at either Time 1 or Time 2 (N = 138), those reporting job strain at both times (N = 15), and two groups that changed job strain status. We repeated this analysis comparing Times 1 and 3 as well as Times 2 and 3.[95] Multiple regression analysis was used to examine the cross-sectional associations of AmBP with job strain, as well as to predict 3-year and 6-year change in AmBP (from Time 1 to Time 2, Time 2 to Time 3, and Time 1 to Time 3) with job strain change, controlling for age, body mass, race/ethnicity, smoking status, alcohol consumption, education, sodium, and physical exertion level of the job.

Among the findings from the Cornell Worksite AmBP study is the observation in all three cross-sectional analyses (Times 1, 2, 3) of consistent significant effects of job strain on AmBP.[95] Subjects with job strain had work SAmBP/DAmBP that was 5–7/3–5 mmHg higher than subjects without job strain. Moreover, those men facing chronic job strain—working in high-strain jobs at two points in time—had work SAmBP/DAmBP on average 10–12/6–8 mmHg higher than those with no job strain at both times. The two crossover groups had intermediate levels of BP. Effect sizes for chronic 3-year exposure to job strain were larger than the estimated effect of aging 25 years or gaining 50 pounds in weight. In longitudinal analyses, subjects who changed from exposure to job strain to no exposure 3 years later had a decrease in SAmBP/DAmBP of about 5/3 mmHg.[95]

These findings lead to the following conclusions: (1) The relationship between job strain and AmBP has been replicated on three separate occasions, enhancing the validity of the initial observation first reported in 1992.[95,97] (2) Repeated exposure to job strain is associated with the highest levels of AmBPs. (3) Changes in job strain status predict change in AmBP over 3- and 6-year periods. (4) Job strain emerges in this research project as a consistent and substantial risk factor for hypertension in men.

Most importantly, these findings for men have been replicated in recent studies conducted among women. Four out of six studies of job strain that used AmBP found an effect.[12,52,106,110] There is evidence in the study by Laflamme and colleagues that the effect of exposure to job strain on AmBP is persistent beyond working hours, as university-educated women exposed to high job strain had an average of 6 mmHg ($p = .012$) higher SAmBP than nonexposed women over a 24-hour working day.[52] In addition, as in the Cornell Worksite AmBP study, repeated exposure to job

strain showed a substantially greater effect on AmBPs than exposure at only one point in time.[52]

Evidence that Changing Job Characteristics Leads to Lower BP

The question arises whether or not *preventing* exposure to job strain (including taking action to remove job strain for those already exposed) might not lead to lower BPs for working men and women, and to the prevention of stroke and CVD. The Cornell study sheds some light on this issue of the impact of changing job characteristic on AmBP. The authors reported that:

> *Those with job strain at Time 1 but not at Time 2 had a significant decrease in AmBP at work and home after controlling for other risk factors. Based on a comparison of regression coefficients, the effect of no longer being exposed to job strain at Time 2 on change in work and home SAmBP is comparable in magnitude, but opposite in direction, to the effect of aging 15 years or gaining more than 40 pounds. The decrease of 5/3 mmHg in work and home AmBP is larger than the observed treatment effect on BPs (2–4 mmHg systolic, 2–3 mmHg diastolic) of a weight-reduction intervention in four clinical trials. Moreover, the fall in work AmBP in this group is largest (–11.3 mmHg SAmBP and –5.8 mmHg DAmBP) among those subjects who entered the study as cases (i.e., subjects with elevated casual BPs at recruitment, N = 10). This finding suggests that the removal of job strain, especially for those with elevated BP, can result in a substantial reduction in AmBP. The amount of decrease in AmBP when job strain is removed is proportional to the initial height of AmBP—the greater the entry AmBP, the greater the fall.*[97]

The following case is illustrative of the potential impact of changes in job characteristics on AmBP. One of the employees in the Cornell study went from reporting having job strain at Time 1 to not having job strain at Time 2, accompanied by a dramatic fall in his AmBP. His interview on the NBC Nightly News on November 23, 1998 provides anecdotal support that positive changes in his worklife led to lowered job strain.

> Reporter: *This participant from the Cornell Study was one of those middle-level managers for a liquor manufacturer. He had very high blood pressure, until he got a promotion.*
>
> Participant: *I had accomplished a couple of key things that gave me a track record, which made me feel good, and I feel much more in control of what I'm doing.*

In addition to the evidence from the Cornell Worksite BP study, two recent intervention studies have examined the impact of worksite changes on casual measures of BP. Kawakami, et al. implemented a stress reduction program among blue-collar workers that included organizational changes.[48] This was intended to alleviate symptoms of depression due, in part, to overwork. Machine work was streamlined, production steps were reduced, and on-the-job training to enhance skills was introduced, thereby reducing job strain. While the study design was not optimized to detect workplace BP changes, nonetheless there was observed a decrease in casual systolic and diastolic BP of 4.4 mmHg and 2.5 mmHg, respectively, that approached statistical significance. A study of urban bus drivers by Rydstedt and colleagues found that an intervention intended to improve traffic conditions, thereby decreased route time and perceived workload among drivers, led to significantly fewer job hassles and lower systolic BP in the intervention group.[93] These

studies provide evidence of the feasibility of worksite interventions intended to reduce worksite stressors and lower BP.

The Best Intervention for Elevated BP

A 5 mmHg decrease in BP brought about by nonpharmacologic means (such as weight loss) may result in lower risk of heart disease than a comparable fall in BP due to antihypertensive drug treatment. The effect of no longer being exposed to job strain in the Cornell AmBP Worksite Study was comparable in magnitude to losing more than 40 pounds. However, the effort needed for large numbers of working people to successfully achieve this goal is daunting indeed! These findings support the potential benefit of a public health approach. Workplace interventions to reduce or prevent job stress (e.g., increased job control to reduce job strain) should receive priority as an important preventive and therapeutic modality for individual workers and, probably most importantly, for groups of workers. Nonpharmacological interventions (such as weight reduction) to lower BP are recommended for individuals with mild elevations of BP, while treatment with medications is reserved for those who have developed sustained hypertension.

There are a number of possible worksite interventions to reduce psychosocial stressors, such as job strain, associated with increased BP. It is feasible to intervene at the worksite on each or all of the key dimensions that constitute iso-strain (demands, control, and support).

First, workload demands can be limited by, for example, attenuation of time pressure and more realistic deadlines and caseloads. As conflict is an important component of the Karasek demand scale, clarifying roles and diminishing conflicting instructions may result in lowered perceived demands by an employee. Note that when people report working hard, they often are referring to excessive work hours; thus, interventions to limit the length of the work week, and work day as well as increase work breaks may reduce reports of psychological demand.

Second, decision latitude can be increased—for example, through training to increase skills, or by providing workers with enhanced authority over their work.

Third, social support can be increased in a number of ways, including improved supervisory techniques and group activities. Most importantly, efforts to promote collective work activities should be maximized. A consequence of enhanced collectivity is usually an increased sense of empowerment, which impacts favorably on decision latitude.

In addition, while other identified work stressors have not been examined here, a number of work related psychosocial variables, such as effort-reward imbalance, are amenable to change (see Chapter 2).

Discussion and Conclusions

Readers of this article may reasonably point to a great need for additional evidence that reducing job strain leads to lowered BP, and assert that an intervention trial should be conducted. This author concurs that a high priority should be given to further validating the role of job strain and other psychosocial stressors in causing hypertension and CVD and in determining that changes in these risk factors result in improved health and cardiovascular status (see Chapter 13 for a further discussion of interventions).

However, while intervention studies are highly desirable in establishing causal relationships, from a public health perspective they are not believed absolutely essential before acting to reduce an exposure believed harmful to the public (e.g.,

cigarettes and lung cancer).[92] This is especially true if the benefits from an intervention greatly outweigh any possible harm. Assessments of harm must include the potential negative impact on both the individual and the workplace, with the latter including an assessment of the *social costs* of workplace change as well as the economic impact on the company. In addition, much of the economic costs of work-induced CVD have been transferred from business to society (an externality of costs), as illnesses become particularly burdensome after employees retire from work. These costs need to be included in any cost-benefit analysis.

The lack of definitive evidence regarding the benefits of reducing job strain on hypertension should not deter individuals, especially clinicians, in a position to effect changes at the workplace from doing so, for the following reasons:

- Reducing work stress (e.g., job strain) may lower BP and reduce risk for heart attack.
- Lowering work stress has a number of potentially salutary effects on employees (e.g., improved mental status).
- Work reorganization may prove cost effective as a means of controlling CVD. The costs of interventions that enhance decision latitude, reduce demands, and increase social support should prove less expensive and more effective in the long run as a means of reducing cardiovascular risk than current medical and drug treatments or other interventions (e.g., weight loss for BP control).
- Employers gain twofold from work reorganization, first through a healthier work force and second because reducing work stress frequently leads to greater job productivity and job satisfaction for employees.
- Most importantly, it is unethical to withhold an effective intervention.

The recent exciting discovery that work stress (e.g., job strain) is an important risk factor for hypertension and CVD and, most importantly, that a reduction of job strain is associated with a substantial reduction in BP opens the door to possible interventions at the workplace aimed at reducing work stress and thereby lowering BP or preventing its increase. The critical question becomes—Do we have enough evidence to justify initiating these interventions? We need not wait for definitive evidence of the causal role of job strain. Both the employee and the employer stand to gain from interventions. The reduction of work stress promises wide-ranging benefits to individuals in the form of better CVD health, improved mental status, greater job satisfaction, and more energy for the rest of their lives. For companies the initial economic costs will be offset in the long run by reduced medical costs and a healthier, more productive workforce. A win-win situation, if there ever was one.

THE CLINICIAN'S ROLE *by Samuel Melamed, PhD, and Paul Froom, MD*

Evidence from well-designed, methodologically rigorous studies points to the effectiveness of worksite-based intervention targeted to modify risk behaviors, reducing physiological CV risk factors.[39,61,71,83,114] However, evidence that such interventions subsequently lower CV morbidity and mortality is limited, based on relatively old studies, and contradictory.[6,51,91]

Worksites have become increasingly attractive points for such interventions for a number or reasons: (1) many adults who would not otherwise seek out risk reduction service through traditional healthcare outlets can be reached repeatedly and at relatively low cost; (2) the convenience of preventive services offered at the