CARDIOVASCULAR EVALUATION OF THE WORKER AND WORKPLACE: A PRACTICAL GUIDE FOR CLINICIANS

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While the empirical evidence presented in Chapter 2 strongly suggests that psychosocial, ergonomic, and physical workplace stressors make an important contribution to risk of CVD, the workplace has yet to become an integral consideration for clinical cardiology. In recent textbooks and/or millennium reviews in cardiology, hypertension, and internal medicine,[8,13,14,25,43,47,51] the work environment is only minimally discussed with respect to CVD; most often this area is ignored entirely. Consequently, there are very few guidelines (with the exception of those related to physical activity levels) to help clinicians make informed recommendations concerning occupational factors as these pertain to individual patients with various degrees of CVD severity. The challenge remains, as articulated over a decade ago by Giorgio Maisano,[28] to offer the cardiac patient a style of life and of work that protects both his or her health and right to be productive.

THE OCCUPATIONAL HISTORY AS IT RELATES TO THE CARDIOVASCULAR SYSTEM

Maisano insisted that in order to achieve the aforementioned goal, understanding of the job and the work environment, in addition to a functional evaluation of the patient, is absolutely essential.[28] This recommendation would be more feasible if it applied to medical disciplines such as pulmonology, hepatology, nephrology, or hematology, for which assessment of exposure to specific (albeit numerous) chemical agents should suffice. However, given the large panoply of diverse workplace factors potentially affecting the CV system and, especially, the seeming difficulty of evaluating psychosocial stressors, the clinician might well be disinclined to even attempt such an endeavor.

The following text outlines a fairly streamlined, systematic, and comprehensive approach (Table 1) to taking an occupational history as it relates to the CV system. This approach facilitates the inclusion of a single, concise paragraph as an obligatory part of the standard clinical history. An example of such a paragraph is presented. This information provides other colleagues with insight not only into the fixed characteristics of a given occupation, but also about modifiable work conditions which could most acutely affect CV well-being.

The first step (see A) is to indicate the current occupation, and determine whether it falls into the high-risk category.[6] Be as specific as possible; for example,

TABLE 1. Clinical Evaluation of Objective Occupational Stressors Relevant to the Cardiovascular System: Present and Past History

Step A: Type of Occupation. High Risk Category?	Step B: Job Characteristics	Step C: Specific Work Conditions	Step D: Exacerbating (New) Conditions	Step E: Larger Questions
Strong Evidence Professional drivers* Air traffic controllers Sea pilots Smelter workers Workers in the explosives industry Chimney sweeps	*Disaster Potential* Danger of serious accidents (hazardous tasks)* Serious (even fatal) consequences of error or lapse of attention (threat-avoidant vigilant work)** Threat of physical violence from other people**	Long work hours* Night work/other unphysiologic schedule* Few/no rest breaks** Physical exposures: noise*, cold*, heat*, vibration*, heavy lifting Cardiotoxins (e.g., carbon monoxide, carbon disulfide, cadmium, mercury, lead, hydro- and fluorocarbons)* Working two or more jobs Conflicting demands on time and space** Interpersonal conflicts (especially with supervisor)	More overtime work than usual New deadlines Recent involvement in or witnessing serious work accident, or other threatening situation* New interpersonal conflicts	Looming possibility of layoff or permanent unemployment Need to change occupation or workplace Minority/refugee/immigrant: discrimination and/or status incongruity Restructuring within the work organization Additive burden from major nonwork stressors
Possible High Risk Lumbermen Police officers Journalists Clerical/sales workers Waste incinerator workers Certain industrial and physical worker categories: (metal processing, paper board workers, sawyers, cement workers, fine mechanics)	*Underload* Monotonous work* Sits out work time with nothing to do Doesn't learn anything new*			
	High Psychological Demand Rapid flow of new information** Receives and transmits important job-related information to other people** Many things going on simultaneously/ must divide attention** Must focus attention on devices** Complicated decision making and/or tasks Supervises work of others			
	Low Control/Physical Constraints Strict time schedule** Paced work No chance for creativity* No influence over work conditions* Works in a confined space/fixed body position** Heavily supervised			
	Socially Isolated			

* Factors present in the sample history, ** Factors strongly present in the sample history

rather than merely noting that the patient is a nurse, indicate where (intensive care unit? well-baby clinic?). Ascertain the number of years in the current job, and obtain a list of all jobs held with approximate dates of employment and relevant details of past work conditions. Pay attention to worsening of cardionoxious working conditions over time. There are, for example, consistent tendencies, albeit of borderline statistical significance, indicating that worsening job decision latitude over time is associated with increased risk of MI.[46]

Next (see B), define the underlying work characteristics. These include many factors that are relatively fixed features of a given job. Modification of these features, if possible, often requires major organizational change. As the clinician becomes more familiar with the occupations of his or her patients, this step can become shorter. Many of the job attributes will be obvious, so that the number of queries posed will be reduced. The clinician should be particularly concerned with jobs exhibiting low control or decision latitude, given the importance of the axis with respect to cardiac risk (see Chapters 2 and 3). When low control is combined with high psychological demand and/or low support, the resulting job strain and isostrain represent a major psychosocial burden that can threaten CV health.

Step C outlines cardionoxious physical, psychosocial, and ergonomic factors that may vary to some extent within an occupation, and may be more amenable to change. The exacerbating conditions listed in Step D could represent trigger mechanisms for acute cardiac events. Finally, in Step E, the larger questions (often cardionoxious) affecting the working individual are considered, such as threat of unemployment; work reorganization requiring change of occupational activity; and minority, refugee, or immigrant status that may result in discrimination and/or status incongruity. Some of these elements are part of the low-reward dimension of the Effort-Reward Model. Note also any nonwork stressors, keeping in mind the additive burden. The latter may be of particular importance to women workers.

This qualitative approach, which we and our colleagues have used successfully in the clinical setting, is based on the Occupational Stress Index[6]; it also incorporates much of the full Job Content Questionnaire,[20] as well as elements from the Effort-Reward Model[41] and the Position Analysis Questionnaire (elements from the latter being associated with cardiovascular disability).[32] Alternatively, much of this information can be acquired using these and other available instruments with a computer-based system, thus streamlining data collection. This type of approach provides the clinician with more time to explore factors that appear to be of critical importance. Whenever possible, information should be obtained using these and other standardized methods and sources (as outlined in Chapter 6). Carefully review any data available from the company and/or the trade union. Insights gained from observational analysis of the worksite are invaluable, and we strongly encourage direct observation, if at all possible. Jennison and Parker note the particular value of open-ended discussion with workers on the job.[18]

Here is a **sample paragraph**, derived from this five-step approach, that could be included in a clinical history:

> The patient has worked for 10 years (prior to this he was a mechanic for 2 years), as an urban bus driver (sole occupational activity) mainly on congested inner-city routes with high threat of violence (has been physically assaulted three times, most recently 2 months ago with superficial lacerations to the right hand) and without a conductor or any ancillary workers in his vehicle. He predominantly works the split shift, starting at 6 AM and driving until 10 AM, then from 2 PM until 6 PM and he does not have time to

go home for the 4 intervening hours. His schedule is very strict; due to heavy traffic he usually is several minutes behind and therefore rarely has any rest breaks. He usually works Monday through Friday; however, at least once and often twice per month he voluntarily works an extra 4 to 8 hours on the weekends, including late night shifts, at the request of the dispatcher. The vehicle which he drives has a major breakdown at least once per month, and there are frequent minor mechanical problems. He has to raise his voice to be heard due to the combinations of vehicular and traffic noise; shock absorption is poor; he feels vibration and fumes inside the cabin; it becomes drafty with temperatures well below 18°C in the winter. His is isolated. There is no air-conditioning. Interpersonal relations within his team are good. He has had no driving accidents. There are no known upcoming changes in organization or work status.

Overall, this patient can be considered to have a cardionoxious job. The patient works in a high-CVD-risk occupation, with a high disaster potential. He is exposed to many elements of high demand and low control, leading to job strain. Numerous additional cardiodeleterious conditions include: long work hours, an unphysiologic work schedule, rare rest breaks, and physical and chemical noxins. The significant negatives include no moonlighting, lack of interpersonal conflicts and driving accidents, and apparently stable macro-work environment.

OCCUPATIONAL CARDIOLOGIC SCREENING AND EVALUATION

After completing an occupational history, if a global assessment is made that the patient's job is potentially cardionoxious, an occupational cardiologic screening and evaluation should follow. A large and ever-expanding array of diagnostic modalities can be applied to the workplace (see Chapter 7). These possibilities present the clinician with a practical dilemma: "For whom and when?" The clinician could aptly bemoan, particularly in the current climate of managed care and cost containment, that it is utterly impossible to nonselectively use these tests in all patients exposed to work conditions potentially harmful to the CV system. The astute clinician is well aware that new, *proactive* paradigms are needed. The very changes underway in the medical system argue for such an approach. Drew and Coye elaborate on this possibility with regard to occupational health and managed care in the 21st century: "It . . . becomes prudent to encourage preventive medicine (wellness) in order to reduce expensive (acute illness, chronic disease state) demand . . ."[11] They encourage health screenings and healthy lifestyle choices. Furthermore, there are increasing efforts to coordinate care and avoid duplications.[11]

In Table 2 we attempt to address these issues by proposing an integrated and *graded* approach to occupational cardiologic workup, based on the degree of acquired CVD severity. We also distinguish between what could be considered the minimal workup needed and those assessments that are either strongly recommended or advised only if feasible. These guidelines have been formulated after taking into consideration existing empirical data on risk stratification and the likelihood of each proposed diagnostic step yielding new, relevant information for clinical decision-making, as it relates to the workplace. (Clinico-physiologic rationale for these guidelines can be found in Chapters 5 and 7.)

We have assumed for this discussion that the clinician is based at a site outside the workplace. Insofar as the clinician has access to the workplace, blood pressure (BP) should be measured at work in *all* patients, including those with normal casual clinic

TABLE 2. Proposed Occupational Cardiology Workup for Patients with Cardionoxious Jobs

Screening Evaluation		Findings: ACVD Severity	Next Diagnostic Steps*		
Minimum	*Strongly Recommended*		*Minimum*	*Strongly Recommended*	*Recommended If Feasible*
Medical history	Worksite BP measurement	Normal-normotensive	Continued surveillance†	Worksite BP measurement	Ambulatory BP monitoring (during work)
Physical exam (BP × 2)	5-minute resting ECG (measure heart rate variability)	Lone borderline HTN	Worksite BP measurement	Ambulatory BP monitoring (during work) Echocardiogram (LV mass)	Holter monitoring (during work) Exercise testing Laboratory testing of work stressors**
Resting 12-lead ECG		Borderline HTN + other signs of CV metabolic syndrome *or* Frank primary HTN	Ambulatory BP monitoring (during work) Echocardiogram (LV mass)	Exercise testing Holter monitoring (during work)	Laboratory testing of work stressors**
Cardiac risk factors Smoking Obesity Sedentary Family history Blood pressure HDL/LDL cholesterol Fasting blood glucose Triglycefides Behavior patterns (e.g., hostility)		HTN + increased LV mass	The above plus: Exercise testing Holter monitoring (during work)		Laboratory testing of work stressors**
Alcohol (for hypertension) Atherogenic diet		Myocardial ischemia and/or previous cardiac events	Clinical cardiology consultation (see Chapter 9)		

* With increasing number of cardiac risk factors, and/or low heart rate variability, upgrade workup

** See text for description

† At least yearly, as per American Heart Association

BP = blood pressure, HTN = hypertension, LV = left ventricular, ACVD = acquired cardiovascular disorders

BP. The limited reliability and diagnostic validity of casual clinic BPs is becoming increasingly recognized. Most importantly, BP measurement at the workplace offers the possibility of detection of at-risk patients whose casual clinic BP remains normal.

Here are a few examples of the logic used to generate these guidelines: Since the cardiovascular metabolic syndrome frequently is associated with an increased left ventricular mass (LVM), echocardiography is indicated for those patients with borderline hypertension together with other evidence of this syndrome. The close relation between amBPs during work and large LVM as well as risk of cardiovascular morbidity should be borne in mind. Patients with increased LVM are at heightened risk for myocardial ischemia. Thus, work-related ST segment depression should be evaluated by Holter monitoring in these patients. Given the septadian data on increased Monday morning risk of cardiac events, recordings should be performed on Mondays or the first day after a nonwork period, if possible.

Laboratory CV testing of workplace stressors can be considered, at present, an ancillary diagnostic modality. In clinical cardiologic practice, laboratory simulation of work activity has been limited primarily to assessing cardiovascular responses to various combination of static and dynamic workplace physical activity, e.g., shoveling, heavy lifting, other upper extremity activity.[10,15,21,23,24,42] Laboratory testing of physiological responses to other physical stressors that affect the cardiovascular system, such as noise, cold, heat, cardionoxious chemicals, glare, and vibration, has been performed in the research setting.[4,7,12,22,27,30,35,50] In principle, testing of this type could be applied routinely in clinical practice—for example, to evaluate the patient's CV reactions to each of the physical noxious agents to which he or she is exposed at work. This type of approach is already well established in other occupational medical disciplines, notably pulmonary medicine.

In the laboratory, it has been consistently reported that "personally relevant mental stress" is a potent stimulus of myocardial ischemia in coronary patients.[17,36,38,39] Discussions about painful or otherwise emotionally-charged events experienced by the cardiac patient are found to elicit heart rate and galvanic skin responses, as well as signs of cardiac electrical instability.[26,48] For 22 young, healthy, male, mainly blue collar workers, discussion in the laboratory during a 10-minute semi-structured interview about intensely stressful workplace events was a more powerful stimulus of pressor reactions (+12.4 / +15.1) than any of five standard mental stress tests.[2] In another report, discussion in the laboratory of a threatening work situation triggered bouts of ventricular tachycardia in a post-MI patient.[45] The only other topic that provoked these arrhythmias was the MI experience itself.

These findings could be used as the basis for laboratory clinical testing in specific relation to the workplace. It may be feasible, in the future, to routinely register CV responses during a semi-structured interview focusing on painful, difficult, and/or dangerous aspects of a patient's work. This approach might be particularly helpful for patients in high-strain jobs or emotionally-intensive work, for those obliged to maintain a high level of vigilance to avert potentially disastrous consequences, and for those exposed to other major psychosocial hazards.

As a general principle, the greater the exposure to potential cardionoxins from the workplace, the more intensive the workup should be, especially if multiple standard cardiac risk factors are present. The independent prognostic significance of low heart rate variability for various patient strata also suggests that the workup be upgraded with this finding. The clinician should be particularly cognizant of the potential association between work stressors and modifiable risk factors such as smoking, obesity, and sedentary leisure time (see Chapter 2).

Screening evaluation or further workup may reveal CV abnormalities other than the acquired CV disorders, which merit clinical attention. Any relation to workplace exposures should be evaluated; e.g., cobalt-, arsenic- or other toxic cardiomyopathy; antimony exposure and prolonged QT interval; nephrotoxin-induced secondary (renal) hypertension.

MODIFICATION OF THE CARDIONOXIOUS WORK ENVIRONMENT: WHY WE CAN'T WAIT

The impact of workplace intervention on CV well-being is the subject of intense investigation (see Chapter 13). Some experts have contended that without data from controlled workplace intervention trials, it is premature to recommend workplace modifications. Muir states that while such recommendations may "seem pragmatically to make good sense, evidence is lacking from intervention studies that introducing these changes will reduce the likelihood of CHD events."[31]

There is, however, an emerging body of observational data suggesting that changes in psychosocial working conditions (as well as lack of such) may have an important impact on clinical CV outcomes among hypertensive and young MI patients. Schnall and colleagues demonstrated among hypertensive men followed over 3 years that change from exposure to nonexposure to job strain (N = 10) was associated with a mean fall in unmedicated ambulatory workplace BP levels of –11.3/–5.8 mmHg, after adjusting for age, body mass index, alcohol, and smoking status.[40] Those hypertensive patients who continued to work at high-strain jobs for the 3 years showed persistently high BP levels. Among 79 men who had survived a first MI before the age of 45, return to work at a high-strain job was a significant, independent predictor of mortality related to ischemic heart disease (IHD) after 5 years of followup, in a study by Theorell and coworkers.[44] The predictive strength of return to high-strain work was of comparable magnitude to degree of angiographically assessed coronary atheromatosis, and more powerful than left ventricular ejection fraction. This finding remained robust after adjustment for standard cardiac risk factors.

Among professional drivers a significant relation has been found between number of years on the job and development of hypertension.[3,5,34] Furthermore, in a small cohort study with 4-year followup of male workers up to the age of 40 at intake, Uglješić and colleagues reported that 66 professional drivers who continued in that occupation had a mean increase in casual BP of +10.9/+9.6; this was approximately twice the BP rise found among 31 examined building trade workers.[49] In contrast, the drivers had only a mean increase of 1.7 kg body weight over followup, while the building workers gained 2.2 kg.

In our opinion, the above-cited data coupled with clinical experience argues that *ethically* we cannot wait for the definitive results of intervention trials to begin to address what the clinician can do to promote cardiovascular well-being in a cardionoxious workplace. Table 3 presents a suggested approach, based on the degree of acquired CVD severity. For workers who are still healthy or have lone borderline hypertension, the recommendations are more or less educational, and linked to public health efforts to improve the workplace. However, even among these workers, overtime work should be strongly discouraged, given the evidence implicating long work hours and CVD and suggesting that the total burden of cardionoxious work increases in relation to duration of exposure.

Since borderline hypertension is an early pathologic state, which may revert to normotension or progress to frank primary hypertension,[1,9,19] based on the data of Schnall, et al.[40] it seems justified to recommend that the patient lower his or her job

TABLE 3. Clinician Options for Promoting Cardiovascular Well-Being in a Cardionoxious Workplace

Degrees of Acquired CV Disorder Severity	Suggested Approach
Normotensive–healthy	Educate and promote empowerment/bolster social support Encourage positive changes at work Facilitate longitudinal study and workplace intervention trials Strongly discourage overtime work Promote salutogenic use of break time (exercise, positive social interaction, relaxation)
Lone borderline hypertension	*The above plus:* Advise patient to lower job strain profile, if at all possible Retain a high index of suspicion that this may be a "sentinel event" Help initiate workplace intervention trials whenever feasible
Borderline hypertension + CV metabolic syndrome or Frank primary hypertension (especially if LVH)	*The above plus:* Use ambulatory BP monitoring to find and then recommend work schedule or conditions with minimum BP Strongly discourage split and night shiftwork; noise, heat, or vibration exposure; heavy lifting Eliminate overtime work and exposure to pressogenic chemicals (e.g., lead)
Silent myocardial ischemia	*The above plus:* Use Holter monitoring to find and then recommend work schedule or conditions with minimum ischemia Minimize job strain and exposure to heat and cold Eliminate early AM, night, and split shifts, and heavy lifting
Post-acute cardiac events	Maximal efforts by clinician to realize all of the above (see Chapter 9)

CV = cardiovascular, LVH = left ventricular hypertrophy

strain profile, if at all possible (of course, without creating other major life perturbations). The clinician should retain an index of suspicion that borderline hypertension or more severe manifestations of acquired CVD in the face of a cardionoxious workplace may represent an occupational sentinel event, defined as: "a disease, disability or untimely death which is occupationally related and whose occurrence may: (1) provide the impetus for epidemiologic or industrial hygiene studies; or (2) serve as a warning signal that materials substitution, engineering control, personal protection, or medical care may be required."[29]

In addition to the standard clinical measures and cardiac risk factor interventions that comprise usual care for patients with more advanced degrees of acquired cardiovascular disorders, individualized workplace modifications could represent another therapeutic modality. Here, the clinician could play a unique role in integratively evaluating the results of ambulatory monitoring to find work schedules or conditions that are the least deleterious to the cardiovascular system. Some individual reports of the success of this type of approach have been published.

Kavanagh and Matosevic present several cases of coronary patients in whom exercise testing was normal, but for whom situations involving mental overload combined with exposure to physical stressors evoked hemodynamic signs of marked sympathetic arousal, leading to several millimeters of ST segment depression.[21] Specific modifications in the patient's work environment were consequently instituted, with favorable clinical results as well as preservation of the patients' employment status. Thus, it has been recommended that the prevalence and severity of

ischemic, arrhythmic, and hemodynamic abnormalities be assessed during actual work, with a detailed diary kept so that the influence of specific occupational activity on CV parameters can be followed.[21,23,24,42]

Belkić and colleagues presented a case report of an obese, hyperlipidemic, borderline hypertensive city bus driver—a current smoker with a very strong family history of IHD—admitted to the coronary care unit for chest pain.[6] His occupational history was similar, though somewhat less severe, than the one presented on page 215. In conjunction with standard risk factor and pharmacologic measures, the clinician suggestion that the patient change from a split-shift to the afternoon shift (which the patient preferred) was implemented. At 4-month followup, the patient had quit smoking, lost 14 kg, and lipid and BP levels were diminished. It was concluded that "this case demonstrates that modifiable workplace and standard cardiac risk factors can be closely interrelated . . . When the clinician can recognize this and intervene in both of these spheres, there is a much better chance for successful prevention in high-risk patients."[6]

The above-cited cases illustrate another important principle with regard to the role of the clinician in suggesting workplace modifications. Namely, that the suggestions be made with careful consideration of the wishes of the patient. It is important to keep in mind that these patients are, more often than not, in their most productive years and highly motivated for work. Depriving them of their occupational activity can have devastating consequences for themselves and their families.[16,23,28,33] Thus, iatrogenically compromising employability should be avoided and respect for confidentiality scrupulously maintained—particularly when there are looming possibilities of lay-offs within the work organization. With the consent and, optimally, the participation of the patient, "medical practitioners or their designates" should try to work with employers to create a more salutogenic work environment for cardiac patients.[37] If queried, patients themselves may give realistic, insightful ideas into how this might be accomplished. Ambulatory monitoring then offers the possibility of objectively examining whether and how specific modifications in work conditions actually provide some benefit to the patient.

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