

## EVALUATION OF WORKING ABILITY OF THE WORKERS SUFFERING FROM CARDIOVASCULAR DISEASES

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Within the disability evaluation process, three different and potentially conflicting roles for the clinician become clear: patient advocate, provider of information, and medical adjudicator. It is important to understand the requirements of each of these roles so that the patient can best be served. The working ability evaluation is a process of numerous examinations, measurements and estimates that are done by a team of medical and other experts. It is utterly unacceptable to think that the opinion about someone's working ability is given by some individual specialist of any expert domain especially regarding the invalids category since this can lead to either confusion or undesired conflicts between the patient and those who are professionally and legally qualified to evaluate his working ability. In order to carry out the medical part of the expertise for evaluating the working ability it is necessary have an accurate diagnosis of particular disease, an opinion whether the process is define or can be improved by and adequate therapy in addition to the state of morphology and function of all the organs and systems essential for responding to the biological requirements of the working operations at a given job as well as the estimate of the functional ability of the organs or system. The practical evaluation of the working ability also has to include the professional utilization factor, that is, it is necessary to determine the working operations requirements as well as the conditions in which they are performed at a given job. Within the working ability it is necessary to take into consideration the psychosocial structure of the sick person, years of age, qualification and professional degree as well as the society's position to accept the proposal made by the medical and other experts. In judging the working ability of the patients having a cardiac disease it is indispensable to view every case separately since it always implies its own factors. The evaluation must be done in specially-qualified institutions having an adequate team of experts including a specialist of occupational medicine, a cardiologist, a safety at work expert, a technologist, a psychologist, a social worker and other medical and non medical staff. *Acta Medica Medianae 2004; 43(3): 59-71.*

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### **Introduction**

Basic knowledge needed by clinicians for treating work incapacity and performing effective impairment and disability evaluations includes an awareness of the distinction between impairment and disability, the regulations of specific disability systems, familiarity with the impairment rating process, and a sensitivity to the social and legal contexts of disability. The health care provider willing to become more informed about the process of impairment and disability determinations can provide an important service to patients.

Patients frequently present to clinicians with a chief complaint (or symptom) of inability to work. Such visits may be triggered by:

1. the patients need for medical treatment to return to work, or

2. a requirement for medical evaluation or certification of „disability“ by employers, insurance companies, or governments agencies. The medical evaluation and treatment of work incapacity is surprisingly complicated, both medically and sociologically, and provides unique challenges to the clinician.

The purpose of this chapter is to increase clinician's effectiveness in dealing with work incapacity by describing

1. key definitions related to the disability evaluation process,
2. common features of disability insurance plans,
3. the clinicians role in the disability evaluation process and
4. the unresolved controversies and potential conflicts for the clinician.

In reviewing the variety of compensations plans and the associated roles for the health care provider, it is important to recognize a few key concepts. Most important is the distinction between *impairment* and *disability*.

Impairment is defined as the loss of function of an organ or part of the body compared to what previously existed. Ideally, impairment can be defined and described in purely medical terms and quantified in such a way that a reproducible measurement is developed.

Disability, on the other hand, is usually defined in terms of the impact of impairment on societal or work functions. A disability evaluation would therefore take into account the loss of function (impairment) and patient's work requirements and home situation. Certain agencies use a more restrictive definition of disability; for example, the Social Security Administration defines disability as „inability to perform any substantial gainful work. Often, private disability insurance defines disability as an „inability to perform the essential tasks of the usual employment“. In all cases, the determination of disability is predicated on an assessment of impairment, followed by a determination of the loss in occupational or societal functioning those results from the impairment. In general, the determination of impairment is performed by a health care professional (usually a physician), whereas the determination of disability and extent of disability may be done by a person who is not a physician using physician-generated information on impairment.

A worker who is injured and cannot do any work because of the injury is totally disabled. If this person can work but has some limitations and cannot do his or her customary work, a partial disability exists. Either type of disability is temporary as long as a complete resolution of the impairment is expected. When no significant functional improvement is expected, it is inferred that a medical end result (sometimes called maximal medical improvement) has been achieved. Often, disability compensation systems assume that if a condition has not changed over a one-year period, then a medical end-result has occurred, and a temporary (partial or total) disability would then be legally regarded as a permanent disability.

A work related injury or disease has resulted from some exposure (physical, chemical, biological, or physiological) in the workplace. In acute traumatic injuries, the relationship of the injury to the workplace is usually clear. In chronic conditions, however, it may be difficult to be medically certain of the relationship between work and disease. It is recommended that the physician's determination of work relatedness should be based on the evidence of disease, the exposure history, and the epidemiologic evidence linking exposure and disease (1).

Health professionals must be aware, however, that the legal definition of cause may be less exacting than the medical definition and that most disability systems are based on the legal standard. A legal definition of a work-related condition is one „arising out of or in the course of employment“ or “caused or

exacerbated by employment“ (2). Thus, a preexisting condition, unrelated to work, that becomes substantially worse because of work may legally be work related. The legal standard of proof is that a condition is work-related if it is „more likely than not“ that the condition would not have been present had the work exposure not occurred.

### Disability compensation system

This chapter describes disability compensation system in the United States.

Some of confusion regarding disability assessment stems from the multitude of disability plans, since each has its own definition of disability and criteria for impairment. The majority of compensation systems, however, fall into one of three major categories (Table 1).

Occupational physicians are most familiar with workers compensation insurance, which is offered to federal, state, and private employees. All of these plans are designed to provide compensation for medical expenses and lost wages due to work-related injuries and illnesses.

The federal government sponsors the major compensation programs for the severely disabled. These programs pay a limited amount of compensation to those who are unable to achieve gainful employment regardless of cause of disability.

Private disability insurance is often purchased by individuals or provided as an employer or union benefit and is designed to provide compensation for those who are unable to work at their regular jobs regardless of the cause of disability.

So, a patient who can no longer work because of injury or illness might receive support from his or her employer's insurer, a federal or state agency, or a private insurance policy that has been purchased.

Although each plan has different eligibility criteria and payment schedules, all share a few common features:

1. In every plan, many people or employers at risk of financial losses contribute to a pool, from which a few individuals are reimbursed. This uses the concept of shared risk. The cost of entering the pool for an individual is partially determined by the actuarial risk of future events for that person. Thus, private disability insurance (often purchased to supplement benefits available through Social Security for non work related disability) is much more expensive per year for a 55 year old than for a 20 year old, since the older worker has a higher risk of disabling medical illness. Workers compensation insurance is more expensive per employee for a construction company (higher risk of injury to employees) than for a stock brokerage firm.

2. Because payments into the pool are predictable, finite resource are available to the potential recipients in each plan. Therefore, eligibility criteria are structured so that the limited resources go to those in greatest need. Workers compensation plans often do not replace lost wages for fewer than six days of

Table 1. Categories of compensation systems in United States

Program	Eligibility	Source of benefits	Basis for claim	Clinician's role
1. Workers compensation system-cause of disability is determinant				
State	Private employees	Employer insurance	Work-related illness or injury	Evaluate work-relatedness, impairment, and disability
Federal	Federal employees	Taxes		
Railroad	Railroad employees	Employer		
Black lung benefits	Coal miners	Tax on coal	Lung disease	Report chest x-ray, pulmonary and function tests and examination results only.
2. Programs for severely disabled- inability to perform gainful activities is determinant				
Social Security Disability Insurance	Contributing workers	Workers contributions, Taxes	Severe disability	Evaluate and report impairment
Supplemental Security Income	The aged, blind, and severely disabled			
3. Private disability plans-regardless of cause, protect income if unable perform regular job				
Short Term Disability	Enrolled workers	Payments by employee, employer, or union	Any illness preventing usual employment	Evaluate impairment and disability
Long Term Disability				

absence from work, since doing so might greatly increase the cost of the program. Many private disability insurance plans do not begin coverage until 30 days to 6 months of illness absence has occurred. The Social Security Disability Income plan does not begin payments until a year of sickness absence has occurred.

3. Before medical evaluating of impairment, a potential recipient of benefits must first demonstrate legal eligibility. The basis for eligibility is different in each plan. For example, to be eligible for Social Security Disability Insurance, one must have worked for 5 of the past 10 years. Workers compensation covers only regular employees † not consultants or subcontractors. Private disability insurance often does not cover illness occurring during the first 60 to 90 days of enrollment.

4. Medical information on impairment is requested once a legal basis for a claim has been established. In every system, a medical diagnosis is necessary. In the workers compensation system, physicians are also asked their opinions on the work relatedness of employee's conditions, the prognosis for eventual return to work, and the restrictions or job accommodations that might be necessary to return the worker to employment.

5. The information from the physician, however, does not determine whether benefits are awarded or how much is paid. All of these systems are under administrative control. In the Social Security Disability Insurance system, an administrator-physician team reviews the medical information from the evaluating physician and compares it with specific criteria for eligibility. In the workers compensation system, if there is a significant discrepancy between

the employer's report of an injury and the physicians report, benefits may be withheld pending an investigation by the insurance company.

6. Benefits are limited and are intended to provide only a proportion of lost wages, medical expenses related to the specific impairment, and vocation rehabilitation. Only in rare circumstances are workers compensation benefits intended to punish gross negligence by an employer in causing the injury.

7. Any applicant has right of appeal of an administrative or medical decision, with review by a third party. In the Social Security Disability Insurance system, applicants who are initially denied benefits can appeal to a second administrator-physician team then to a Social Security benefits coordinator, then to an administrative law judge, and finally to the federal courts, if desired. In most workers compensation plans, the claimant can request an administrative hearing and be represented by an attorney. The agencies providing benefits also conduct periodic reviews of cases to verify that continued eligibility (disability) exists.

The United States does not have a unified workers compensation law, and each state has developed its own system. In addition, there are a number of workers compensation programs that are occupation specific. These programs often have developed their own definitions of disability and related eligibility criteria. The Black Lung Program, for example, provides payments to coal miners with a documented work history and respiratory insufficiency meeting certain criteria. All disabling respiratory insufficiency is assumed to be related to mining if the miner meets a standard of number of years worked in the mines. Other examples of occupations with workers compensation type programs include railroad workers,

longshoremen, military veterans, and municipal workers such as police and firefighters.

The purpose of each plan is to reimburse workers for medical expenses, rehabilitation expenses, and lost wages that result from a work related injury or illness. Plans are designed to be no adversarial so that, in most cases, limited benefits are paid to injured workers without the necessity of a formal hearing. In most cases of acute traumatic injuries (for example, fractures or lacerations occurring at work), the relationship to work is unquestionable and the system works reasonably well at compensating the injured worker. In many cases, however, the relationship to work is less clear, and the demand on the physician more complicated.

The Social Security Administration, in the U.S. Department of Health and Human Services, administers two plans that provide benefits to those unable to work regardless of cause for the disability.

**Social Security Disability Insurance** is a true insurance plan in that all nongovernmental employees in the United States contribute to the plan through mandatory deductions from wages. Eligibility requires 5 years of contributions to the plan over the previous 10 years and is determined by the federal Social Security Administration. State rehabilitation commissions are given the responsibility of determining whether the applicant's impairments qualify for benefits. To qualify, impairment must be the result of a documented medical illness and must be expected to result in at least one year of inability to work, or death, but does not have to be a consequence of work. Once a claim is accepted, there is a six † month waiting period until benefits begin. Claims are reevaluated periodically to determine that a severe impairment continues to exist, and updated medical information is requested. The condition must be as severe as the standard description listed in the Social Security Administrations publication *Disability Evaluation under Social Security*. If conditions are not listed in the regulations, it must be medically equivalent to one that is listed. A sufficient impairment must result in inability to perform any gainful employment, not only the person's usual job. In cases where the impairment does not meet the established criteria, the examiner will take into account age, education, and prior work history in determining the likelihood that an applicant would be able to find any future employment.

**Supplemental Security Income** is a program, funded through federal taxes (not by employee contributions), for blind, disabled, or elderly people who do not qualify for Social Security Disability Insurance. Although criteria for disability are identical to those for Social Security Disability Insurance, benefits are generally lower and do not begin until the claimants assets and benefits from all other sources are exhausted.

**Private disability insurance** is available from over 25 different insurers in the United States. These programs provide benefits supplementing Social Security Disability Insurance and have much less stringent criteria for acceptance of claims. Usually, the

claimant need only have his or her physician that impairment exists that prevents working at the usual job. Most plans provide a fixed income level for the first two years of disability, if one is unable to work at his or her usual job because of illness. Afterwards, full benefits are paid only if the claimant is totally disabled from (any type of) work. If the claimant can do work with lower wages than previously, the difference between current potential wages and prior wages determines the reimbursement level. Programs usually provide for maintenance of health insurance and certain other employee benefits, and benefits usually end at retirement age. Many variations and supplements exist that can be purchased by an employee. The next case illustrates a typical situation that would be covered through private disability insurance.

A 60 year old male maintenance worker, who formerly smoked cigarettes, was referred by his employer for a return to work evaluation. The patient had been out of work for 3 months following hospitalization for an inferior myocardial infarction. Despite a good medical regimen, the patient continued to have fatigue after minimal exertion but no chest pain. His home activities were limited to 20 minutes of walking twice a day. On physical examination he was in no acute distress, with a resting heart rate of 80 beats per minute. His lungs were clear to auscultation, and his heart sounds showed a normal rate and rhythm without murmur or gallop. The ECG showed evidence of his myocardial infarction. A recent exercise test had been discontinued after 4 minutes because of fatigue, but there were no signs of active ischemia or arrhythmia. His job as a maintenance worker involved walking long distances in the plant, pushing a 45 kg maintenance cart, and performing scheduled and unscheduled machinery repair.

In summary, this patient showed evidence of cardiopulmonary deconditioning after a myocardial infarction. The patient demonstrated decrease exercise capability by his symptoms and exercise tolerance test performance. This deconditioning would probably prevent him from performing his normal job tasks. He had probably not achieved a medical end result by the time of his evaluation. It would, therefore be appropriate to refer this patient to a cardiac rehabilitation program in an attempt to increase his exercise tolerance before making any judgment about permanent impairment. He would be supervised in a progressive exercise program, which might restore much of his exercise capacity. Until fit enough to return to work, this patient would be eligible for continued short term disability compensation from his company sponsored plan. This patient would not be eligible under Social Security because the disability was not expected to last more than one year and did not meet the relevant guidelines. Since outcome of rehabilitation efforts may be difficult to predict at the outset, the treating physician would want to monitor the patient's progress and reevaluate his disability once a plateau in reconditioning has been reached.

### Steps in the disability evaluation process

The following questions are involved in disability evaluation:

1. What is the patient's medical diagnosis?
2. Does the individual have any impairment related to this diagnosis? If impairment is present, is it temporary or permanent?
3. What is the extent of any impairment?
4. Is the patient's impairment or disease caused or aggravated by work?
5. What is the impact of this impairment on the individual's ability to obtain employment in specific occupations and to perform specific jobs?
6. In consideration of the answers to the above questions, to what, if any, economic benefits are the individual entitled?

Physicians generally play a major role in answering the first four questions but not the last two. The answer to the fifth question often depends on the specialized skills of a vocational evaluation unit and is based on legal administrative criteria. The last question is usually resolved by administrators using legal guidelines.

Physical examination findings that support the degree of impairment and the stated diagnosis are important. For example, Social Security Disability Insurance claims without positive objective physical findings (symptoms without physical or laboratory findings) are rejected. Evaluations often include measurement of strength and endurance, length of scar, degree of visual impairment, and other relevant items. Serial measurement of these findings over time provides an objective basis for deciding whether a medical end result has been achieved. Since the physician's office usually has meager resources to fully evaluate functional capacity, referral to an occupational therapist or vocational evaluation specialist for work capacity evaluation may be appropriate. A series of standardized tasks can be performed to document functional impairment (3).

The physician is often asked to determine whether the impairment is permanent or whether a medical end result has been achieved.

At times, insurance companies or lawyers ask for a determination of permanency that seems to require a crystal ball. In many cases, the prognosis for functional improvement is uncertain. Pressure from a lawyer or insurer may be present to declare a medical end result so that a case can be settled. However, it is important to communicate uncertainly, both to the patient and to others involved with the case. Patients do not benefit from a premature medical determination of permanent disability.

In workers compensation and in private insurance disability cases, the physician is often asked whether the impairment is disabling-in what way it impedes the person's usual work. A clear job description is the basis for evaluating whether the employee can perform all the essential functions of the job. Often, this cannot be determined without knowing what accommodations at work might be available. The same considerations apply to determining

disability for private insurance. A visit to the workplace usually will resolve the lack of clarity that frequently is present in standard job descriptions and may have important role in encouraging an employer to provide accommodations for an injured employee.

Most insurance systems theoretically reimburse individuals for loss of earning capacity caused by objective impairment. It is often difficult to determine whether sufficient impairment exists for one to qualify for benefits under a given plan. Physicians usually lack the experience, technical facilities, and ability to accurately estimate vocational potential. Specialized skills and a broad data base are required to predict residual earning capacity when an employee is no longer able to return to previous work.

### The clinician's role

Within the disability evaluation process, three different and potentially conflicting roles for the clinician become clear: patient advocate, provider of information, and medical adjudicator. It is important to understand the requirements of each of these roles so that the patient can best be served.

Clinicians must not neglect their role as patient advocate in treating patients with work incapacity and, when appropriate, assisting them in obtaining benefits to the extent entitled by a particular disability system. The clinician should not let personal feelings about a specific disability or impairment rating system interfere with judgment in assisting patients. As patient advocates, clinicians need to be aware that depression is often a complicating factor in the patient with long term disability. Patients frequently are limited financially and socially by their work incapacity, and social isolation frequently accompanies isolation from the work place. Patients may be upset at how they have been handled by the system especially if benefits have been delayed or denied. They may be angry at the apparent insensitivity of their employer, insurer, or physician and this anger often complicates their evaluation and treatment. Patients are often afraid of returning to the work place where a serious injury occurred, or they may be afraid of being dismissed once they have successfully returned to work. Being aware of the complicated social, legal, and psychological state of disabled workers is an essential aspect of assisting their recovery. Appropriate referral for psychological diagnosis and treatment should be considered in every case of prolonged work incapacity. Mindful of the adverse psychological, physical, and economic consequences of disability, the clinician should be careful to avoid removing patients from gainful employment, whenever possible.

Patients may also have significant concerns about the disability evaluation itself. Since patients are aware that the outcome of the evaluation may determine their access to or continuation of benefits, they may feel the need to emphasize the extent of the disability to „prove“ their case. They may have residual anger from previous examinations in which clinicians seemed unsympathetic or doubted their „true“ disability.

As a patient gradually loses function because of a progressive disease process, the physician should anticipate the possibility that earning capacity may be lost and discuss this potential with the patient. Patients should be made aware of the potential loss of self esteem and income and the uncertainty of receiving benefits while out of work. Actively assisting patients in vocational rehabilitation and early selection of jobs that will not conflict with physical limitations can avoid unnecessary time out of work. Physicians should learn of possible accommodations in their workplace by contacting the personnel manager or the patient's supervisor. With this information, the physician can often help the employee return to work earlier, thus preserving earning capacity and often providing an additional stimulus to recovery.

In the routine care of patients, clinicians will frequently be asked to provide information relating to their patients medical condition for the purposes of determining impairment or disability. Such requests may originate from employers, insurance companies, state agencies, or patients. When such requests are accompanied by the patients signed requests for release of information, or is appropriate to release information that is relevant to the request. Since records relating to workplace injuries must be routinely supplied in workers compensation cases, it may be worthwhile to make and provide office notes that are separate from the notes relating to other, non work related problems. Since a workers reimbursement is frequently tied to the receipt of records from the attending clinician, it is important that clinicians be prompt in responding to such requests to minimize financial difficulties for their patients.

Several sources information can aid in the provision of relevant information. For example, most private disability plans have a short guide on eligibility requirements for clinicians, state workers compensations boards often publish free guide books on the subject, and the Social Security Administration office will provide a free copy of the disability determination guide. The greatest potential conflict arises between the primary clinician's traditional role as patient advocate and his or her gatekeeper and adjudicator role, brought about by a request from an employer or insurance company for professional evaluation of impairment. This situation can lead to hostility between patient and clinician because of unrealistic expectations and inexperience with disability systems. Frequently, patients are not aware of the requirements of different systems and will blame their clinicians if benefits are denied. Clinicians will frequently share their patient's frustration with the arbitrary nature of a particular disability system. Clinicians occasionally resent their patients for "trying to take advantage" of an insurance system, and patients may rightly resent the need to "prove" their illness. All of these feelings may interfere with a satisfactory clinician-patient relationship.

When a clinician is acting as an adjudicator, therefore, it is important to clarify the purpose of the evaluation and the limitations of the clinician to refer the patient to a social worker, lawyer, or union

representative for clarification of the social, legal, and financial issues surrounding application for disability. It is often appropriate for a clinician to seek an independent opinion about impairment and disability when there is a potential for conflict with a patient or significant uncertainty about the cause or extent of disability.

### **Rehabilitation management for work related injuries, occupational and work related diseases**

The physical restoration and ultimate reorientation of injured workers and workers with occupational and work related diseases has become a multi-focal process involving a multidisciplinary team of professionals. Members of this team include physicians, physical therapists, occupational therapists, occupational health nurses, and safety personnel. In large corporations, all team members may be within the same health unit. For small employers, the team members may be consultants to the workplace or be professionals practicing in the community. Regardless of the settings, it is essential that the team be clearly identified and utilized.

However, here the process of triage, diagnosis, and treatment are predicted on unique information:

1. A clear understanding of the workers job, especially those physical demands contributing to the injury or diseases, and
2. Environmental and other physical demands the worker will encounter.

A plan to eliminate or minimize factors that contributed to the injury should be implemented prior to the workers return and should be coordinated with the physical restoration process. The therapist may also be able to assist in task redesign and worker instruction in proper material handling techniques, if deemed appropriate (4, 5).

Program design must be specific to the nature of the injury or disease and expected physical demands. Simulated work tasks should also be incorporated into any restoration plan (6). Modification of treatment approach may be necessary and will largely depend on the team's ability to identify both the physical and emotional signs of any delayed recovery (7).

What makes return to work optimal is a medical release that addresses specific alternative jobs or tasks that the worker can safely perform and includes a timetable for progressive reemployment, if the worker is unable initially to sustain a full workday. This kind of specific medical release is only possible if the restoration program is designed to yield this type of information from its start.

The successful rehabilitation of workers depends on a team approach. Program design must address expected physical demands while the contributing factors of the original injury and disease are identified and controlled, if not totally eliminated, prior to return to work.

## Cardiovascular disorders

Cardiovascular diseases, including hypertensive disease, ischemic heart disease, other forms of heart disease, and cerebrovascular disease are responsible for more deaths and temporary or permanent disability to work. Each year than any other category of disease, even though the death rate from ischemic heart disease has declined markedly over the last two decades (8). Because cardiovascular diseases cause so much mortality, preventing even a small increase in risk due to occupational exposures can involve large numbers of people and represent an important health measure.

Personal risk factors that contribute to the development of coronary heart disease have been well studied, but the contribution of working conditions to this disease has been explored very little. The American Heart Association recognized this gap in knowledge and recommended that occupational epidemiologic studies be performed (9).

### Risk factors for coronary heart disease

Risk factors associated with coronary heart diseases can be divided into three categories:

1. Personal,
2. Hereditary and
3. Environmental

Personal risk factors include sex, age, race, high serum cholesterol (most specifically low density lipoprotein / total cholesterol ratio), high blood pressure, and cigarette smoking. The interaction between these factors is strong enough that a smoker with both high blood pressure and hypercholesterolemia is 8 times more at risk of developing coronary heart disease than a non smoker who has normal blood cholesterol and normal blood pressure (10) (Table 2).

Table 2. Personal risk factors associated with coronary heart disease

Risk factors	Feature
Sex	Mortality rates for women lag behind those of men by about 10 years
Age	Risk increases with age
Race	Prior to age 60, white males have lower death rates than non white males. The inverse is true after 60
High serum cholesterol	Risk estimated at 1.7±3.5
High blood pressure	Risk estimated at 1.5±2.1
Cigarette smoking	Risk estimated at 1.5±2.9

Other personal risk factors, such as obesity, diabetes, and lack of physical exercise, have been associated with coronary heart disease, but their roles are considered minor compared with those cited above. In certain families, the risk of coronary heart disease is high and is correlated with a number of

blood relatives who have developed the disease and the early age at which they developed (11).

### Occupations as risk factors for coronary heart disease

While the association between personal risk factors and coronary heart disease is well documented, our knowledge of the role of occupational and environmental risk factors is still limited. Several chemical and physical agents have been suspected of causing coronary heart diseases in workers chronically exposed to them. However, scientific evidence indicates a direct causal relationship for very few of them. For most of these agents, the evidence is based on isolated case reports or on a few unconfirmed studies. Table 3 lists some occupational hazards associated with cardiovascular disorders.

Table 3. Occupational hazards associated with cardiovascular disorders

Hazard	Effect	Strength of evidence
Carbon monoxide	Atherosclerosis	Weak
Carbon disulfide	Atherosclerosis	Satisfactory
Certain aliphatic nitrates	Coronary spasm	Strong
	Atherosclerosis	Weak
Arsenic	Coronary heart disease	Satisfactory
Lead, Cadmium	Coronary heart disease	Satisfactory
Noise	High blood pressure	Strong
Shift work	Coronary heart disease	Weak
Halogenated solvents	Arrhythmia	Satisfactory
Chronic hand arm vibration	Vibration white finger	Strong

### Carbon monoxide

The potential for exposure to carbon monoxide in industry is high. This odorless and colorless gas is produced in most process where there is fire, combustion, or oxidation. High exposures may occur in many workplaces, such as steel and iron foundry, petroleum refineries, pulp and paper mills, and plants where formaldehyde and coke are produced. One of the most common and insidious sources is the internal combustion engine. Workers in garages and enclosed parking spaces may be chronically exposed to fairly high levels of carbon monoxide. Fire fighters, apart from the usual hazards of their work, may be exposed to excessively high levels of carbon monoxide in smoke.

Carbon monoxide causes a variety of signs and symptoms, dependent on concentration of exposure (12) (Table 4).

Table 4. Progressive effects of exposure to carbon monoxide

8 hour average concentration (ppm)	Carboxyhemoglobin concentration (%)	Main signs and symptoms
0	0.1±1.0	No signs or symptoms. Normal endogenous level.
25±50	2.5±5	No symptoms. Compensatory increase in blood flow to certain vital organs. Patients with severe cardiovascular disease may lack compensatory reserve.
50±100	5±10	Visual light threshold slightly increased
100±250	10±20	Tightness across the forehead. Slight headache. Visual evoked response abnormal. Possibly slight breathlessness on exertion. May be lethal for fetus. May be lethal for patients with severe heart disease.
250±450	20±30	Slight or moderate headache and throbbing in the temples. Flushing. Nausea. Fine manual dexterity abnormal.
450±650	30±40	Severe headache, vertigo, nausea and vomiting. Weakness. Irritability and impaired judgment. Syncope on exertion.
650±1000	40±50	Same as above, but more severe with greater possibility of collapse and syncope
1000±1500	50±60	Possibly coma with intermittent convulsions and Cheyne Stokes respiration.
1500±2500	60±70	Coma with intermittent convulsions. Depressed respiration and heart action. Possibly death.
2500±4000	70±80	Weak pulse and slow respiration. Depression of respiratory center leading to death.

Exposure to high concentrations of carbon monoxide (over 1,500 ppm) can cause sudden death by anoxia. Exposure to low concentrations decreases myocardial oxygen consumption, concomitantly increases coronary flow and heart rate and lowers exercise tolerance of healthy persons. When a person already suffers from a certain degree of coronary insufficiency, such consequences may manifest by an increase of the ST segment depression on electrocardiogram, the onset of angina pectoris (13), and occasionally by acute myocardial infarction (14, 15).

However, the association between chronic exposure to low levels of carbon monoxide and the development of coronary atherosclerosis leading to coronary heart disease has shown in a few studies (16, 17). Literature data indicates that low exposure to carbon monoxide accelerates the development of atherosclerosis in laboratory animals when combined with a diet rich in saturated fats, especially when exposure consists of intermittent peaks (18). The few studies conducted so far among working groups have been unable to show a distinct relationship between chronic exposure to carbon monoxide and the development of coronary heart disease. The known association of coronary heart disease with cigarette smoking, combined with observations that workers intermittently exposed to peaks of carbon monoxide have higher risk of heart disease, keeps this question open to further research (19).

### Carbon disulphide

Of all the chemicals for which an association with heart disease has been studied, carbon disulphide (CS<sub>2</sub>) shows the most convincing evidence. Although this chemical is used mostly as a solvent and in the production of organic chemicals, paints, fuels, and explosives, its use in the viscose rayon producing industry revealed this association. Mortality studies of viscose rayon workers who were exposed to CS<sub>2</sub> have shown that they are at 2 to 5 times greater risk of dying from heart disease than unexposed workers. Reduction of exposures reduces the risk to workers (20). In one study, the excess mortality declined from a relative risk of 4.7 to 1.0 over a 15 year period after implementation of exposure reduction measures (21).

The mechanism by which CS<sub>2</sub> causes heart disease is not known, although it is hypothesized that it may be through changes in cholesterol metabolism with promotion of atherosclerosis of the coronary arteries (22, 23).

### Nitroglycerin and other aliphatic nitrates

Some aliphatic nitrates are potent vasodilators of coronary vessels. This property has long been used for the treatment of angina pectoris. However, it has been reported that some workers exposed continually to nitroglycerin, and in particular to nitro-glycol, during the manufacturing of explosives have suffered from angina pectoris on withdrawal from exposure. This phenomenon, which occurs on weekends or on vacations, disappears on return to work. The mechanism involved is thought to be a coronary spasm. The reversal of this spasm by the administration of nitroglycerin has actually been observed with angiography during the withdrawal period.

Studies have reported elevated risk for coronary heart disease after some 20 years of exposure, which seems to indicate that nitro compounds are not only responsible for acute vasospastic reactions but may also increase the risk of coronary heart disease after



long exposure by an increase in high blood pressure and atherosclerosis.

### Metals

Poisoning by metals, such as lead, cadmium, and arsenic, is recognized as capable of causing coronary heart disease after long exposure to high levels (24). For lead and cadmium, this effect is a consequence of the renal damage caused by these metals. This effect is so remote from their actual toxicity that mention of it should be reserved for the description of their renal effects (25, 26, 27).

There are studies in the literature that seem to indicate that exposure to arsenic and cadmium released during the smelting of copper may increase the rates of coronary heart disease, but this hypothesis remains unproven (28).

### Noise

High levels of noise, exceeding 85 dBA, are common in the workplaces. There are few factories, smelters, or mines where hazardous noise is never a problem. The association between chronic exposure to high noise levels and hearing loss is well documented.

Some researchers have proposed that noise can also damage the cardiovascular system indirectly by causing high blood pressure and, over a long period, may lead to atherosclerosis of the heart and blood vessels. Intermittent and impact noise would seem to be more harmful than continual noise in this respect (29, 30, 31).

Acute exposure to high levels of noise initiates cardiovascular responses that mimic the effects of acute stress: that include increases of blood pressure and heart rate, blood levels of catecholamine and lipids, such as low density lipoproteins and fatty acids, and vascular tone of peripheral vessels (32).

These changes are transitory, however, and disappear a short time after exposure ends (33).

### Psychological stress

Among other less well defined risks of coronary heart disease in the work environment is a wide array of psychological stress factors. The most widely studied of these is type A behavior pattern in "an individual who chronically struggles to obtain an unlimited number of goals in the shortest possible time, often in competition with other people or opposing forces in the environment" (34).

An extensive review of the evidence on the association between coronary heart disease and type A behavior (35) concluded that population studies demonstrate type A behavior to be a risk factor for coronary heart disease among healthy working men, but not for recurrent events or for mortality in men having had a first heart attack or suffering from angina pectoris. Subsequent studies seem to point out that

anger and hostility are associated both with type A behavior and coronary heart disease. These personality traits could well become the most meaningful risk factors to be considered in the future.

Contrary to previous beliefs, white collar workers who exposed to the more stressful psychological environment of the decision are making process have shown lower mortality and incidence rates of coronary heart disease than blue collar workers. These effects can be explained by the high socioeconomic status of white collar workers and possibly also by their greater degree of control over their work environments, however, it could also indicate a risk associated with the physical stresses and exposures to pollutants of a blue collar working environment (36).

Psychological stress is associated with the arterial hypertension and coronary artery disease (37, 38, 39).

Shift work, night work and excessive overtime have been suspected of being associated with coronary heart disease (40, 41, 42, 43, 44).

### Occupation as a risk factor for cardiovascular disorders other than coronary heart disease

Some cardiovascular disorders other than coronary heart disease have also been associated with exposure to chemical and physical agents at work. Among the most noteworthy are myocarditis, congestive heart failure, cardiac arrhythmias, Raynaud's phenomenon, and skin teleangiectasia.

An epidemic of fatal cardiomyopathies was reported among heavy beer drinkers after several breweries had added a foam-stabilizing, cobalt-containing substance to the beer. It has been suggested that the synergistic effects of alcohol, cobalt, and protein poor diet were at the root of the cobalt induced cardiomyopathy, whose symptoms resemble thiamine deficiency (45). Although reports on industrial exposures to cobalt suggest important consequences for the heart, the situation remains unclear.

In their advanced stages, silicosis, asbestosis, severe asthma following exposure to toluene disocyanate and other pulmonary diseases may develop into right sided heart failure. This condition, called chronic cor pulmonale, can be regarded as the terminal stage of a long chronic evolution of the disease.

Acute exposures to some halogenated and non-halogenated industrial solvents, such as toluene, xylene, chloroform, and trichloroethylene, and to fluorocarbon aerosol propellants have been associated with sudden death. The mechanism underlying this effect is presumably a fatal cardiac arrhythmia. Case reports indicate that these sudden deaths are usually preceded by high levels of exposure to the solvents and concurrent stress, resulting in activation of sympathetic nervous system.

Chronic exposure of the hands to vibration from vibrating tools, such as pneumatic drills, hammers,

chisels, riveting tools, metal grinders, and chain saws has been associated with a vascular syndrome affecting the fingers. This syndrome called Raynaud's phenomenon or vibration white finger; manifests by an episodic whitening of the fingers accompanied by numbness or complete loss of sensation. The toes can also be similarly affected. On recovery, there is reddening and tingling of the affected areas accompanied by pain. In forestry, the prevalence of this phenomenon has been estimated to be over 30 percent (46). After several years of exposure, the syndrome becomes so disabling that the affected worker is forced to leave the job.

Another vascular phenomenon that has been associated with specific job is skin teleangiectasias in aluminum workers. Primary aluminum reduction workers have developed numerous red spots on their chest, back and upper limbs. These maculae are clusters of teleangiectasias. Apart from their unaesthetic appearance, they do not seem to carry any other health significance. Neither the mechanism involved nor the causal chemical is known at this point, although it is proposed that a fluoride element bound to hydrocarbon molecule excreted by the sweat may account for the phenomenon (47).

### **Cardiovascular disorders and cigarette smoking**

Although ant tobacco campaigns have succeeded in decreasing the number of smokers, many workers still smoke cigarettes. It is therefore appropriate to stress the relationship between smoking and coronary heart disease.

More studies have estimated the risk of coronary heart disease among smokers to be in the order of 2.5 as compared with nonsmokers. It seems that this risk is associated more closely with the number of cigarettes smoked per day than with the number of years of smoking. Investigations demonstrate that this risk is reversible after a person stops smoking: The risk decreases to the level of a nonsmoker after 10 years of abstention (48).

### **Screening for coronary artery disease in asymptomatic workers**

The use of exercise stress testing has been proposed as a means of screening out from strenuous jobs those persons who are at high risk of developing ischemic heart disease. This concept stemmed from the results of several studies showing that symptomatic persons undergoing exercise stress testing who present a lowering of the ST segment on ECG develop 3 to 5 times more coronary heart disease after 5 years than those without this ECG change.

This type of screening may seem attractive, particularly in situations where persons are working under conditions that may represent a higher risk of coronary heart disease, such as regular exposure to low levels of carbon monoxide or working in stre-

nuous jobs. However many sound arguments militate against this approach:

1. the low reliability of exercise stress testing in predicting the development of coronary heart disease,
2. discrimination in hiring of workers on unproven grounds,
3. the unavailability of preventive measures for those identified as being at higher risk,
4. the association of risk with numerous other factors and
5. the existence of risk associated with the testing itself.

After weighing all considerations, the benefits that can be gained from exercise stress testing to screen out persons potentially at risk of coronary artery disease appear to be substantially outweighed by the drawbacks. The procedure cannot be recommended for asymptomatic persons.

Stress echocardiography is most sensitive methods than exercise stress test (49).

### **Return to work after myocardial infarction**

There is no consensus on a policy for employment of workers returning to work after a heart attack, after heart surgery, or during active treatment for ischemic heart problems. Most cases are dealt with on an ad hoc basis.

The cardiologist is generally the physician who must decide when it is medically permissible for a worker who has suffered a recent myocardial infarction to return to work. The existing guidelines are meager. The healing period normally lasts from 6 to 8 weeks. The usual procedure is to advise the patient who has been moderately active outside the hospital during convalescence to resume work on a part time basis for example, 2 to 4 hours daily, while avoiding symptoms, fatigue, and emotional tension. The patient is cautioned to avoid public transportation and rush hour traffic, as well as to limit after hours social functions.

With the advent of specialists in exercise physiology and the development of cardiac rehabilitation centers, much has been done to quantitate job requirements, to assess the capacities of heart attack victims through performance testing, and to reassign workers to job tailored to their capacities.

Different methods have been developed to ensure sensible matching of the heart patient to the job. Assessment of caloric expenditure required by a job allows matching with the ability of the patient to attain that level of expenditure without symptoms. Job simulation in rehabilitation centers is another technique useful in assessing a heart patient's ability to accomplish a specific job. The use of telemetric ECGs for on the job monitoring allows direct evaluation of the subject's capacity. Many patients will not be able to avail themselves of this approach. In many case, occupational physicians should visit the workplace to assess hazards.

Modern technologic refinements and major developments in cardiology have succeeded in remo-

ving the stigma of frailty often associated with a heart attack victim: a more positive approach that benefits both the worker and the employer now prevails, although there are still good reasons for caution.

For ensuring protection and gaining personal confidence in the capability to return to work, the heart attack victim should return to work in a gradually progressive manner, based on a schedule prepared with the occupational physician. Part time, light work, and rest periods longer or more frequent than usual should be considered. Shift work should be avoided.

Victims of heart disease should not perform job tasks in which the safety of fellow workers or of the general public is directly concerned, such as driving public transport transit vehicles, piloting aircraft, and erecting scaffolding. Other than these types of work, there are no clear guidelines regarding what work such individuals are capable of performing.

A worker who has suffered a heart attack needs to resume work after recovery for economic as well as psychological reasons. With modern treatment, the risk of high absenteeism is much less than previously believed and is most likely negligible. The lack of motivation that can arise from remaining at home, coupled with long periods of inactivity and over-protection by a spouse, are factors that contribute most to a permanent handicap after a myocardial infarction.

### Coronary heart disease and workers compensation

Even though coronary heart disease is considered to be a personal disease, it can, in certain circumstances, be recognized as work related. Legal expert's opinion on the causal relationship between heart attack and work lie between two extremes:

1. an approach based on the lack of full understanding of the etiology of this disease, leading to an uncritical acceptance of exertion as the precipitating factor in its appearance in the workplace, and

2. a systematic rejection of any claim on the basis that coronary heart disease is essentially of personal origin and that on medical opinion on the existence of causal relationship can be substantiated.

In the most North American workers compensation programs, coronary heart disease is considered to be an injury caused by accident rather than an occupational disease. The presence of an accident originally meant that some "unusual exertion" was a necessary precondition, but its definition has varied much with time and place (50).

1. It is reasonable to assume that most courts of law will accept cases when four conditions are met:

2. the asserted heart pathology is well demonstrated,

3. the coronary heart disease has followed an exertive activity, not encountered normally in the execution of the work (often this is in relation to an emergency situation),

4. the heart attack took place immediately or in a reasonable period of time after the effort,

5. and physician states that the exertion, more probably than not, triggered the attack.

There seems to be general agreement that fire fighters and policemen are at high risk for coronary heart disease and, accordingly, several states have favorably considered compensation cases for these workers. The impetus for such an attitude has been a concern over the physical and emotional stresses of both occupations, and, in addition, the chemical hazards encountered in fighting fires.

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## OCENJIVANJE RADNE SPOSOBNOSTI RADNIKA SA OBOLJENJIMA KARDIOVASKULARNOG SISTEMA

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U procesu ocenjivanja radne sposobnosti doktor medicine ima tri ključne, različite i potencijalno konfliktne uloge: ulogu bolesnikovog advokata, ulogu davaoca informacija i ulogu sudije. Neophodno je razumeti svaku od ove tri uloge kako bi bolesnik bio sagledan na najbolji način. Ocena radne sposobnosti je proces mnogobrojnih ispitivanja, merenja i procena koje zajednički obavljaju medicinski i drugi stručnjaci. Potpuno je neprihvatljivo da mišljenje o radnoj sposobnosti daju specijalisti pojedinci bilo koje specijalnosti u smislu kategorije invalidnosti jer to može dovesti do zabune i nepotrebnih sukoba između bolesnika s jedne strane, i onih koji su stručno i zakonski kvalifikovani da ocenjuju radnu sposobnost. Da bi se obavio medicinski deo ekspertize za ocenu radne sposobnosti neophodna je tačna dijagnoza određenog oboljenja, mišljenje da li je proces definitivan ili se stanje može poboljšati adekvatnom terapijom, stanje morfologije i funkcije svih organa i sistema bitnih da odgovore biološkim zahtevima radnih operacija na radnom mestu i procena stanja funkcionalne sposobnosti organa ili sistema. Kod praktičnog ocenjivanja radne sposobnosti neophodno je uključiti faktor profesionalne utilizacije, odnosno odrediti zahteve radnih operacija i uslove u kojima se oni obavljaju za konkretno radno mesto. U okviru radne sposobnosti neophodno je imati u vidu psihosocijalnu strukturu obolele osobe, godine starosti, kvalifikacionu i stručnu spremu i mogućnost društva da usvoji predloge medicinskog i drugih stručnjaka. Pri ocenjivanju radne sposobnosti srčanih bolesnika treba posmatrati svaki slučaj izolovano pošto on nosi sa sobom osobine koji su karakteristični samo njemu. Ovakve procene moraju obavljati za to kvalifikovane ustanove sa adekvatnim timom stručnjaka u kome će učestvovati: specijalista medicine rada, kardiolog, inženjer zaštite na radu, tehnolog, psiholog, socijalni radnik i drugo medicinsko i nemedicinsko osoblje. *Acta Medica Medianae 2004; 43(3): 59-71.*

**Ključne reči:** oboljenje srca, ocenjivanje radne sposobnosti, radno mesto, koronarna bolest