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Return to work and cardiovascular disease: functional capacity assessment, evidence and limits of applicability and the role of cardio-rehabilitation in occupational medicine

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Abstract

The incidence and prevalence of cardiovascular disease are increasing progressively in the general population and workers due to higher mean age and improved prognosis and survival as a result of new therapeutic and diagnostic options. The assessment of cardiovascular risk in the workplace is complex due to the fact that it is not a specific work risk and because of the absence of a specific assessment methodology, leading to numerous limitations in the formulation of the job fitness certification, the protection of workers' expertise and health, and the applicability of regulations. The tools used in cardiology and, particularly, in cardio-rehabilitation can provide important information to both estimate the residual functional capacity and the cardiovascular load during work activity. A multidisciplinary approach and collaboration between occupational physicians, cardiologists, cardio-rehabilitators, and general practitioners are essential for managing critical cases.

Key words: job fitness, return to work, cardiovascular disease, occupational medicine, occupational cardiology, cardio-rehabilitation.

Introduction

Cardiovascular (CV) diseases are one of the leading causes of death in Western countries. Incidence and prevalence are increasing progressively, also due to average age rise of population, and other demographic factors (increase in life expectancy, reduction in the number of births).

In the last five years, some authors introduced the "occupational cardiology", a rising discipline that could be important in the future in occupational medicine, in the appliability of current regulations, employment policies and occupational health, in social and economical implications. An editorial entitled "Welcome to occupational cardiology, at present more questions than answers" already highlights the complexity of clinical and functional assessments between cardiology and occupational medicine, and limits between occupational risk assessment and worker functional assessment [1-4].

Epidemiology and cardiovascular risk factors

CV diseases are among the "big killers" in Europe, causing over 4 million deaths a year. They affect more women than men (2.2 million against 1.8 million), although the incidence shows a countertrend in general population under 65 years of age [5]. In Italy, CV diseases are the main cause of death (44%), as reported by the Istituto Superiore di Sanità in the CUORE project.

According to data reported by ISTAT (National Institute of Statistics), the average age of workers in Italy increased in last years, due to the progressive ageing of the population and a reduction in the number of young people entering the labour market. There is a significant increase in the number of workers who continue to work after reaching retirement age: in 2021, 78.6% of active pensioners were at least 65 years old, with an increasing trend compared to previous years [6]. This phenomenon is also related to the growth of the elderly population and a decline in births, resulting in an increase in the proportion of older workers [7]. This also implies an increase in the average age of the working population, with implications for labour market dynamics and pension sustainability.

Risk factors

The role of CV risk factors in the pathogenesis of ischemic heart disease is well established in scientific literature, and a shift from a stochastic approach to precision medicine and metabolomic and proteomic science is rapidly developing. The main risk factors, such as age, gender, serum lipids, systolic blood pressure, diabetes or lifestyles (smoking habit, physical activity) can be classified in modifiable and not modifiable. Ageing, increase of rigidity and resistance of CV structures, and other risk factors as diet and lifestyles are responsible for a pro-inflammatory effect. This condition of systemic stress is the main

mechanism of endothelial dysfunction and atherosclerotic process. It is well known the role of some pro-inflammatory factors in the process of initiation and progression of endothelial dysfunction and coronary disease, such as C-reactive protein, monocyte-1 chemotactic protein, and some interleukin [8-10].

Furthermore, inflammation, beyond endotelial dysfunction, is one of the main causes of oxidative stress with alterations in nitric oxide (NO) release and vasoconstriction, prothrombotic state due to a raised expression of adhesion molecules (VCAM) and chemokine (MCP1), raised of oxidized low-density lipoprotein (LDL) and reactive free radicals [11]. An inflammatory state typical of chronic diseases is associated with normocytic anemia, which in certain situations may have a causal role in acute coronary syndrome by discrepancy.

Some risk factors are associated with a very high predictive value. The SCORE2 working group in collaboration with the European Society of Cardiology classified geographical areas according to risk and developed an algorithm for calculating the risk of CV events in 10 years, easy to apply in clinical practice due to the availability of cards in different languages and units of measurement and based on few clinical findings and history, such as systolic blood pressure, total cholesterol, age and gender, non-HDL cholesterol (high-density lipoprotein) and cigarette smoke [12]. The endothelium dysfunction is characterized by a series of functional and structural alterations, such as proliferation of smooth muscle cells, deposition of collagen and lipids and formation of fibrolipid atheroma.

New diagnostic instruments and laboratory systems are available for the evaluation of endothelial dysfunction. Haematochemical tests may reveal alterations of coagulation mediators, adhesion molecules and chemokines, and cell proliferation factors. Venous occlusion plethysmography, laser-Doppler flow symmetry, peripheral arterial tonometry and flow-dilation mediated by the brachial artery are imaging techniques that allow to diagnose endothelium dysfunction in early stage and in the preclinical or subclinical phase. An increase of 1% in flow-mediated dilatation of the brachial artery is associated with 12% increase in the risk of CV events [13].

Legislation and occupational risks

The effects of occupational hazards on worker's health is well known and documented in literature. Risk assessment methods are internationally standardised by certification bodies (UNI, EN, ISO), which issue technical standards on a regular basis. However, risk management differs between states and is regulated by laws. In Italy, every employer is obliged to appoint a qualified physician as a health and safety consultant. The supervisory task is carried out by public institutions. The different regulations may lead to differences in the applicability of scientific evidence and technical standards, with possible repercussions

in some working situations, as in travel medicine. In France, health and safety at work is entirely the responsibility of public institutions. The Health and Safety at Work Act (HSWA) 1974 is the primary piece of legislation in the UK that governs occupational health and safety.

CV risk is not an occupational specific risk. However, it may be a contraindication to exposure to many occupational hazards, especially those that involve heavy physical work. Furthermore old and new CV risks factors burden must be considered.

The musculoskeletal system is the target organ of heavy weight lifting, but it may involve an extremely variable CV effort, depending by the type of lifting (high loads moved in an explosive manner or carried out in high frequency isometric or lower weight load handling or a combination). The extreme variability of work activity is the greatest limitation assessing CV effort during individual tasks, due to a difficult standardization of the clinical evaluation tools or compared with structured and telemetry training used in rehabilitation cardiology, usually applied into protected environments.

Climate change is a public health concern, resulting in increasing exposure to high temperatures for the general population and workers. Workers exposed to high temperatures are found in different production sectors, such as agriculture and fisheries, construction, maintenance and installation of urban installations (water supply, electricity and gas), transports, outdoor industrial plants. The safety risks may relate to a number of pathological conditions, such as sunburn, heat stroke, muscle cramps due to heat, or freezing in case of exposure to low temperatures. Occupational hazards can also have a synergistic action, such as the manual handling of loads outdoors with high temperatures, and may involve a high cardiovascular effort. A systematic review and meta-analysis published in 2022 show strong evidence of higher CV risk related to exposure to high temperatures [14]. Angina symptoms may be triggered by exposure to low temperatures. High temperatures can cause vasodilation and reduced preload.

Night work is related with effects on physical and psycho-affective health, such as sleep disturbances, digestive disorders, work-family conflict. The CV system is one of the potential target organs for known effects on circadian rhythms and adrenergic tone imbalance, increase of cortisol and circulating catecholamines, resulting in increased blood pressure and a pro-inflammatory, prothrombotic, and arrhythmogen effect (higher risk of ventricular premature beats and increase in QTc). These conditions are related to an higher risk of cardiovascular diseases, more evident in women than in men. The Guidelines of the Italian Society of Occupational Medicine and Industrial Hygiene (SIMLII) mention cardiovascular diseases among the potential temporary or permanent contraindications to night work, with particular attention to ischemic heart disease and severe arterial hypertension [15].

Psycho-physical stress is associated with physiological changes in autonomic regulation with an increase in sympathetic tone, and consequently increased blood pressure, heart rate and peripheral vasoconstriction. Stress is associated with increased cortisol levels which has a role in endothelial dysfunction and atherosclerotic process. Work-related stress is an occupational risk associated mainly with the onset of psychological disorders, including adjustment disorder and chronic post-traumatic stress disorder. A systematic review published in 2017 shows a correlation between work-related stress and hypertension, dyslipidemia, obesity, and glucose intolerance [16]. Some case reports have also documented tako-tsubo syndrome in workers after a stress episode during work activities [17].

Work activities at height higher than 2 meters without a stable floor is related to an increased injury risk and falling accidents, in particular in case of pathological conditions as: implantable cardiac defibrillator (ICD), hypertensive crisis, diabetes mellitus, altered impulse conduction, cardiological conditions with a higher risk of sudden death such as Brugada syndrome type I, long QT syndrome, arrhythmogenic dysplasia. For falling prevention, worker regularly uses the anti-fall protection devices; in case of falling, there may be a risk of "suspension syndrome" due to the tensile forces that these devices can exert on large vessels.

A direct effect by electromagnetic fields on CV system is unknown. However, exposure to non-ionising radiations may represent a risks for workers with implantable devices such as peacemakers and ICD, especially in case of older devices not shielded.

High-frequency repetitive movements of the upper limbs constitute a risk for the development of musculoskeletal disorders, which can be considered in the case of movements involving the use of force or isometry [18].

For certain tasks, it must be considered the increased risk of accidents for all those operations which most expose the worker and any other persons directly or indirectly involved to a risk for safety, particularly for drivers of large goods vehicles and passenger carriers. Some clinical conditions (malignant arrhythmias or canalopathies with high risk of sudden death, carriers of peacemaker, ICD or mechanical ventricular assistance) must be carefully evaluated to avoid accidents which may have even very serious consequences in the workplaces.

There are a variety of occupational sectors exposed to the risks involved. Any type of processing involving manual heavy lifting or processing outside or in adverse microclimatic conditions (agriculture and livestock, construction), working at height or in suspension or in hyperbaric atmospheres (operation and maintenance of industrial plants, work on oil platforms) may represent a risk for health and safety in highly susceptible workers and aggravate pre-existing conditions such as hypertension, ischemic heart disease, heart failure, valvulopathies and heart remodeling. Other more sedentary work (office work, drivers of

heavy vehicles) for the low physical activity and for the greater predisposition to risk factors (cigarette smoking, improper diet), may have a role in higher risk of some heart disease.
The aims of this review is to analyze the main methods of clinical and instrumental evaluation used in rehabilitative and preventive cardiology, assessing their advantages and disadvantages, the limits and applicability of the methods in occupational medicine, aimed to an evaluation procedure of the return to work in workers after ischemic heart disease considering current legislation and regulations on health and safety at work and the latest scientific evidence.

Occupational risk assessment

Occupational risk assessment is a multi-step analysis (identification of hazard factors, evaluation of dose-response curves, worker exposure assessment, risk characterisation) by the employer and occupational physician, who is the only person informed on workers health condition. The analysis of the technological cycle offers very important informations that allows the occupational physician to adapt the work to worker health conditions, allowing workers to continue or resume work. It is appropriate, therefore, that the occupational physician, in addition to taking into account the individual target systems and organs of occupational risks, also consider the CV effort necessary to perform the tasks, in particular for those sectors of employment which are most at risk. A classification of individual tasks through the metabolic equivalent of tasks (METs) estimated through databases could be useful for risk stratification. However, it is hardly applicable in its present state as it is not an official standardized method.

Health surveillance

During health surveillance and medical examination, the occupational physician assess the technological cycle of work interviewing workers, highlighting any discrepancies between what the worker reports and what is revealed by the risk assessment.
The work history must be accurate in studying past exposures or any non-professional exposures from hobbies (gardening or agriculture, sports, music) or other concurrent work activities. The remote pathological anamnesis allows to collect information on previous diagnosed pathologies, time and mode of onset of symptoms, full recovery and prognosis. Medical reports about previously performed instrumental examinations are important for the evaluation of functional recovery, and to keep in touch with specialists who handled the case and assess of the pharmacological therapy in progress. In healthy workers exposed to some of the occupational risks, previous signs and symptoms may suggest CV disease or chronic coronary syndromes, such as angina, dyspnea, syncope, heart palpitations. The physiological history is equally important to investigate the cardiological risk factors

(smoking habit, physical activity). To investigate the quality of sleep and any disturbances or history of snoring, allows to exclude obstructive sleep apnea syndrome, related with high CV risk and important in connection with some occupational risks, as working at heights and driving.

Cardiovascular burden assessment

There is currently no standardised methodology for estimating CV effort during work. Data on work activities are avaiable with a classification system in sectors and an estimate of METs [18-20]. An accurate estimate can be quite difficult due to the complexity and heterogeneity of some tasks, but represent a crucial key to compare the assessment of the worker's residual functional capacity and the estimated for tasks, to identify any contraindications.

Effort perceived intensity is an immediate and sensitive indicator of CV commitment. The Borg RPE (Rate of Perceiving Effort) scale (6-20) and its adapted version Category Ratio 10 (CR10) are two validated scales to quantify effort intensity and estimate indirectly heart rate [21]. Some conversion tables for RPE 6-20 and CR10 in relation to the intensity of physical effort, heart rate, percentage of maximum heart rate (%HRmax), estimation of METs are avaiable. The European Society of Cardiology (ESC) guidelines on preventing CV disease in clinical practice relate some clinical parameters also to the Talk Test, a pratical test for the assessment of physical effort during physical activity [22]. These tools are quick and easy to apply in the workplace, where the usability of some instrumental examinations is complex and sometimes impossible, as they must be carried out in protected healthcare or hospital settings. A review reports that healthy adults and patients with CV disease have a positive talk test (comfortable speaking) corresponding to physical exertion below the ventilatory threshold [23].

The 12-lead basal ECG is the first level instrumental examination essential for assessing the functionality of the conduction tissue of the heart and certainly the most used in Occupational Medicine. It allows to evaluate alterations of repolarization (ST/T tract) for suspect coronary syndromes even in silent clinical conditions; signs of overload may be evident in case of myocardial hypertrophy or hypertensive heart disease; alterations of the excite-conduction, such as complete ventricular branch blocks, presence of premature ventricular contractions may manifest themselves as a result of structural alterations (previous necrosis, arrhythmogenic dysplasia); electrocardiographic patterns typical of certain canalopathies (Brugada syndrome, long QT syndrome) allow early diagnostic suspicions; Some arrhythmias, particularly atrial fibrillation and atrial flutter due to the high incidence in the general population, can be diagnosed even if without any symptoms.

However, some electrocardiographic alterations are not visible during the rest or not detectable during the execution of the basal trace and sometimes it may be necessary to use second-level instrument examinations. The maximum exercise cycle ergometer test allows to study the cardiac electrical activity during a maximum physical exercise and to find repolarization alterations and excite-conduction induced by effort, to study the chronotropic and blood pressure course, evaluate the metabolic consuming by means of METs and observe any alterations during the recovery period. The ergometric test is a repeatable and easily accessible test, which provides many informations about heart activity during physical exertion, despite representing a non-highly sensitive or specific test. Another limitation is the brief duration of the test, as the load (expressed in Watts) is set according to body weight, sex and training degree, for a total duration of 8 to 12 minutes. This allows for an effective maximum test to be performed once 85% of the estimated maximum heart rate has been exceeded; it does not allow an assessment of efforts of lower intensity but more prolonged in time, as during work activity.

The cardio-pulmonary exercise test (CPET) is an ergometric exercise test that measures O_2 and CO_2 exchanges using a metabolometer. It represents the gold standard for the assessment of workers with CV diseases and is also indicated for the assessment of residual functional capacity and the finding of limitations for the release of job fitness certification [24]. CPET measures maximum oxygen consumption during exercise (VO_2max) and assesses both cardiogenic or detraining limitations, as O_2 pulse, WO_2/work, maximal heart rate (HR max). Furthermore, also ventilatory or pulmonary vascular limitations can be detected. CPET allows to establish two pivotal steps in the physiology of physical exertion according to the triphasic model proposed by Skinner and McLellan: the first aerobic threshold (AT) which is defined as the point at which lactate production commences (between approximately 40 and 60% of VO2max), and the respiratory compensation point (RCP), whereby the body's production of lactate exceeds its elimination capacity [25]. Exercise ergometers can be included in health surveillance protocols for those tasks with high CV effort.

Alterations of excite-conduction, repolarization and rhythm disturbances can be revealed by performing a dynamic Holter electrocardiogram monitoring, that consists in recording the electrocardiographic traces for a longer period of time than the baseline (24-48 hours), and to evaluate the heart rate trend compared to sleep and wakefulness and daily activities. It also allows to evaluate arrhythmic events (premature contractions, runs, pauses) sometimes not observed during an examination performed in a short period of time, such as basal electrocardiogram and ergometric stress test.

The 6 minute walking test (6MWT) is a very useful tool for functional evaluation in sub-acute cardiac patient. The test involves the patient having to walk a distance in 6 minutes, quantifying the physical capacity expressed in meters and checking for oxygen saturation

(SaO2), for an initial picture of the residual functional state. It is more accessible than CPET and has a considerable importance in cardio-rehabilitation. There is no evidence of its application in occupational medicine [26].

Imaging techniques are very important second level examinations. Sometimes they are indispensable to conclude the diagnostic path. Transthoracic standard echocardiography is a safe, repeatable and easily accessible examination that allows the anatomical and functional study of the heart. The thickness and size of the chambers, the measurements of the valve structures and the main vessels, the systolic opening of the valves and the Doppler findings, possible alterations in the kinetics (hypo - hyper - akinesia, dissynchronies) can be evaluated. It also allows the sistolic and diastolic functional study (ejection fraction, tissutal Doppler), to evaluate any signs of atrial overload and increase in pulmonary resistance. The echocardiographic examination can be performed at baseline and after physical or pharmacological stress. The eco-stress is carried out after administration of specific drugs (dobutamine and/or atropine), and allows the detection of left ventricular segmental wall kinetics alterations, both during physical effort and in the recovery phase. With the administration of adenosine or dipyridamole it is possible a non-invasive study of the coronary flow reserve (CFR), both in post acute and during follow up, after pharmacological therapy [27]. Cardiac magnetic resonance imaging with contrast and myocardial scintigraphy represent other useful diagnostic tools. Coronary angiography (CA) remains the gold standard for coronary atherosclerotic lesions evaluation even if cardiac CT allows a sensible and specific diagnosis, due to the fact that during CA a stenting procedure treats the stenosis. Cardiac CT has application mainly in screening and in low pre-test probability of disease.

During physical activity, some cardio-circulatory adaptations are needed to improve performance and O_2 consumption, for an enhanced energy production (ATP) compared to anaerobic glycolysis. These adaptations include the activation of sympathetic tone, peripheral vasodilation, increased venous return (due to the mechanical action of the heart and chest system), with an increase in blood flow required by muscle districts of 10 - 30 times the baseline. This is possible due to the increase in cardiac flow, which is related to oxygen consumption as per Starling's law:

$VO_2 = Q \times \Delta_{(A-V)} O_2$.

The increase in heart rate is mainly responsible for the increase in cardiac output, especially in case of de-training. Theoretical maximum heart rate decreases progressively in relation to age and can be estimated using specific calculation formulas. Work intensity, heart rate, systolic output and O_2 consumption are therefore linearly correlated. Considering that the consumption of O_2 at rest is equal to 35ml/min/kg, this value is defined as METs for any activity performed. METs depend directly on body weight and exercise duration, and represent an estimate of VO_2max under maximum effort conditions. The METs also allow to

determine the effort tolerance based on gender and age, but their measurement does not allow to distinguish a reduced tolerance from cardiogenic limitation or de-training, possible by the CPET [18,28]. The heart rate represents the most easily monitored vital parameter directly related to oxygen consumption, and allows to estimate the target heart rate (HRmax) calculated as a percentage of the theoretical maximum heart rate (%HRmax) and the heart rate reserve (namely the difference between the HRmax and the baseline HR) calculated in percent (%HRR) both calculable with certain formulas, such as those proposed by Karvonen). Using wearable devices during the usual work activity it is possible to track heart rate and a comparison with the values obtained during ergometric tests aiming to identify the values exceeding the first AT.

Considering the difficult applicability of CPET in the workplace, both for weighted reference values for specific protocols and due to technical issues, the use of METs allows an estimation of O_2 consumption during work, by means of classified values and tables available in literature, and allows a comparison with the worker's stress tolerance observed during exercise ergometric tests.

Job fitness certification, requirements and limitations

In Italy, the certification of job fitness, ex art.41, paragraph 2, Legislative Decree 81/08, represents the conclusion of the technical, anamnestic, clinical and functional evalutation path, discussed in previous chapters. The certification must consider worker's right to health and work and the protection of his/her professional status. Some parameters in particular, including the pre-discharge clinical course and possible complications, the presence or absence of residual ischemia and the inducibility threshold, signs and symptoms of heart failure, effort tolerance, the ejection fraction of the left ventricle, arrhythmias and their frequency allow to assess the worker CV risk in low, medium, high and represent the main prognostic determinants after an acute coronary event (Table 1) [18]. Some studies report that a cardiopathic worker can perform work activities with an oxygen consumption of about 35-40% (Critical Power) compared to VO_2max and corresponding to the AT. Job fitness certification is allowed if the functional capacity of worker is at least twice as high as the expected energy demand for work activity.

Any requirements and task limitations must therefore be formulated according to the risk stratification and work activities. A medium-high risk counterindicates work activities with significant CV intensity, and requires from the occupational physician in collaboration with the employer the assessment of the technological cycle and a process of adaptation of work to the worker, identifying the light tasks that can be safely performed by the worker (1-3 METs).

Close collaboration between the occupational physician, general practitioner and cardiologist ensures adherence to pharmacological treatment and better control of traditional risk factors. Furthermore, this approach allows consideration of other recognised risk factors, such as psychosocial isolation and family behaviours, when considering the return to work. This approach has been shown to have a significant impact on clinical outcomes, prognosis and quality of life [18].

Limits

The main limitations are technical and methodological. Currently, there is no method for assessing CV risk, as it does not represent a specific occupational risk. The classification of work activities may also be approximate, but doesn't consider a whole range of worker characteristics (body weight, training status, gender). Female workers certainly require different attention and evaluation than male workers. Similar to other occupational hazards (weight constants for lifting, process of chemical metabolite elimination), stress tolerance also has different reference values between sexes, whereas this distinction is not expressed in the databases classifying work activities.

Other limitations are due to psychosocial and family aspects. It is therefore a fundamental aspect that the occupational physician knows worker characteristics in working place and the extra-work environment. Although the assessment of suitability should be made on occupational risks and specific tasks, it is appropriate to consider adherence to therapy, lifestyle and personal habits (obesity, eating habits, smoking, physical activity), important prognostic elements and relevant aspects in terms of health promotion. The communication with the worker must be effective, especially in case of the worker is resistant or even in disagreement with the judgment of the occupational physician, possible and attributable to different factors, as a concern for his/her health. This is perhaps the most critical point, since technical and legislative aspects are not always easily understood by the worker and applies to CV risk as well as to all occupational risks and related partial suitability assessments.

Role of cardio-rehabilitation in functional recovery and occupational medicine

Dr. William Heberden was an English physician and pathologist (1710 - 1801). He described for the first time the clinical characteristics of angina pectoris, and in 1772 reported a clinical case of a man with angina, who had a regression of symptoms after cutting wood with a saw for half an hour a day until he was almost healed. This "case report" is not only the first testimony of the beneficial effects of cardio-rehabilitation, but shows an important starting point for reflection on the importance of physical activity in functional recovery and its impact on work, which does not necessarily represent a contraindication [29].

In the past, treatment for ischemic heart disease included a period of absolute rest in post-acute of several months. The current scientific evidence has shown, on the contrary, that the resumption of physical activity must be encouraged and carried out early and as soon as possible, due to the many benefits on heart remodeling and functional recovery. ESC guidelines published in 2021 on sports cardiology and exercise prescription for patients with CV diseases recommend 150 minutes for week of moderate physical activity or 75 minutes for week of moderate-intense physical activity (evidence class 1A) for a mortality reduction of 20-30% compared to sedentary subjects [30].

New drug therapies are playing a key role in determining the prognosis of acute coronary syndromes. New drugs for the treatment of cardiac insufficiency (neprilysine inhibitors, sodium-glucose cotrasporter-2 inibhitor) are demonstrating an extraordinary effectiveness in the recovery of left ventricle ejection fraction and functional capacity. The cardio-rehabilitative approach, with early diagnosis and targeted drug therapy can help to improve the prognosis and promote the recovery of work of the patient affected by ischemic heart disease with protective measures that are as limited as possible, for all beneficial effects (psychosocial and economic) that the full resumption of work may entail. Numerous studies have highlighted the benefits of collaboration between occupational physician and cardio rehabilitator in functional recovery and management of workers for return to work, with excellent results in maintaining the job and employee satisfaction, low risk of relapse and good psychosocial health quality [31,32].

Conclusions and future perspectives

The worker affected by ischemic heart disease and his return to work represent a type of clinical case in cccupational medicine that will be more and more frequent in clinical practice. The scientific literature offers a number of tools, which are not free from limitations and require conscientious use and evaluation on a case-by-case basis. This will therefore require a multidisciplinary approach and close collaboration between the occupational physician, cardiologists and the general practitioner and all the company characters responsible for prevention and safety at work to optimize functional recovery, improve adherence to therapy and develop practical solutions that allow the worker's recovery from daily work and non-working operations with important implications for quality of life.

Telemedicine is currently making great strides thanks to the development of wearable devices for the remote analysis of the main vital parameters. Considering the development of new technologies such as Artificial Intelligence, it is not excluded that in future these wearable devices with appropriate self-analysis software will provide a fundamental support for the biomonitoring of workers during work, enable an assessment of the cardiovascular effort to monitor the main vital parameters and alert workers immediately on case of a

danger for their safety. For some occupational risks, an approach of this type has been carried out in past even though it is still in scientific research, such as the use of accelerometers to evaluate the biomechanical overload of the upper limb [33].

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Table 1. Prognostic assessment of onset of new acute cardiovascular events. Modified from: Taino et al. (2013) [18].

Low risk	Medium risk	High Risk
- Uncomplicated pre-discharge clinical evolution (no ischemic recurrence, no heart failure); - Good working capacity (> 6 METs); - Left ventricular ejection fraction > 45%; - No arrhythmias (< 10 PVC/h); - Absence of myocardial ischemia at rest and during effort	- Myocardial ischemia at medium inducibility threshold (5-6 METs) - Left ventricle ejection fraction between 30% and 45%; - Ventricular arrhythmias of mild severity (> 10 PVC/h or unsustained VT); - Persistent atrial fibrillation; - Reduced working capacity (< 5 METs).	- Complicated pre-discharge clinical evolution (Killip>II class, recurrence of ischaemia, arrhythmias occurring 48 hours after onset); - Left ventricle ejection fraction < 30%; - Left ventricular ejection fraction 30-45% with low stress tolerance; - Low threshold induction ischaemia (< 5 METs); - Severe ventricular arrhythmias at rest and/or during effort; - Inoperability of the ergometric test due to cardiac causes