

Objective assessment of functional capacity: the role of cardiopulmonary exercise testing

Evaluación objetiva de la capacidad funcional: el papel de la prueba de esfuerzo cardiorrespiratoria

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A significant amount of equipment for cardiopulmonary exercise testing (CPX testing), also known as ergo-spirometry (Figure 1), is currently being distributed in major cardiology services and cardiac centers in the country. These equipments are produced in Cuba at the Central Institute of Digital Research (ICID, for its acronym in Spanish). For its necessary operation and proper employment in our population, our specialists need to be trained in this modern and advanced technology in today's world. Although this technology

was introduced in Cuba more than 10 years ago, it is now that we consider that its use can be generalized across the country.

The meeting known as EuroPREvent-2013, Conference on Prevention and Rehabilitation of Cardiovascular Diseases of the European Society of Cardiology, has just taken place in Rome from April 18 to 20. A session entirely devoted to study CPX testing, particularly its methodology and interpretation, was held in such meeting.

It is known that physical activity and physical exercise training play a key role in cardiovascular prevention and rehabilitation, and also that functional capacity assessment is an essential component in the primary and secondary prevention programs, and it is determined objectively by CPX testing^{1,2}.

However, when functional capacity is assessed by means such as exercise stress testing, some parame-

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Figure 1. Infarcted patient while a cardio-respiratory stress test (ergospirometry) was performed to him to determine signs of myocardial ischemia and assess his heart function as part of risk stratification. An equipment of national production such as those currently distributed in our country is used.

ters: exercise time, maximum workload achieved or tolerated or assumed metabolic equivalent of task (MET), among others, can not be fully reproducible, because they depend on several factors that vary from temperature and humidity to the motivation of the physician and that of the patient to perform physical exertion during the test³. As a result there may be inaccuracy in the determination of the causes for functional capacity deterioration.

In the last three decades, CPX testing has proven its value and therefore has gained widespread acceptance throughout the world and is considered the "gold standard" for assessing functional capacity in healthy and sick subjects, in athletes and for prognostic stratification in patients with cardiovascular disease and with other disorders, in stable clinical conditions, even in patients with left ventricular dysfunction or heart failure^{4,5}.

CPX testing adds other important parameters to the usual measurements obtained by a simple exercise test, such as lung ventilation, oxygen consumption and carbon dioxide production, among others. Therefore, ergospirometry facilitates a series of cardiac and res-

piratory variables whose comprehensive analysis and interpretation are crucial in determining the pathophysiological imbalance and the intrinsic mechanisms which produce functional limitation^{1,6-8}.

In an oxygen-dependent biological system, such as the human body, CPX testing allows the measurement of peak oxygen consumption (VO₂ max), a parameter that summarizes in a simple figure the overall efficiency of transport systems and the use of oxygen, essential gas throughout the body, which explains the recognized assessing and prognostic value of this parameter^{6,7,9}. The cardiac output and stroke volume both at rest and during maximal and submaximal exercise can also be determined, and all this in a non-invasive manner.

Other parameters reflecting pulmonary ventilation, alveolar function, metabolic-ventilatory interaction or anaerobic threshold, play an essential role in prescribing physical exercise, not only in patients with cardiovascular, respiratory or other diseases, but also in healthy untrained subjects and in athletes^{10,11}.

In current times, where there is a tendency to use percutaneous interventions, or high-resolution cardiac imaging or gene therapy in scientific research or in medical publications, and even in clinical practice, stress tests could be seen as no longer applicable¹². However, the role of physical exercise is becoming more prominent in the medical field, if its effects on cardiovascular prevention and rehabilitation, and on other diseases are considered, as well as its association with greater quantity and quality of life when practiced regularly. The CPX testing allows us, through the analysis of exhaled respiratory gases during application of physiological stress, such as physical exercise, to identify with accuracy and reproducibility the functional capacity of the assessed subject and to identify a probable latent myocardial ischemia or other existing pathological conditions¹³⁻¹⁵, as well as to prescribe with accuracy and certainty a program of physical exercises which meet rigorous fundamental physiological principles that are to make it effective and risk free.

Once we are familiar with this technique and it is incorporated into our diagnosis and assessment ar-

senal, ergospirometry will be an essential element in the treatment of patients with ischemic heart disease, in its various forms, even after coronary revascularization through either interventional or surgical methods, but also in patients with heart failure or ventricular dysfunction, valvular diseases, congenital heart diseases, arrhythmias with or without implanted pacemakers or other pacing methods, where resynchronization therapy is included. Also in patients with pulmonary hypertension, respiratory diseases, and in the differentiation of causes (cardiac or pulmonary) of a dyspnea of poorly defined causes. It is also used in the assessment of patients for heart transplantation programs and their subsequent assessment.

CPX testing is an indispensable tool in cardiac rehabilitation advanced systems as well as in the assessment of athletes in their preparation for sporting events (Figure 2). Textbooks^{16,17} and various guidelines have been published in recent years by prestigious international scientific organizations, mainly from the U.S. and Europe, where key aspects of this technique,

especially regarding its indications and usefulness, and the precise interpretation of the results in different diseases^{1,18-23} are expressed and summarized.

Therefore, CPX testing is essential in clinical and research practice of cardiologists, pulmonologists, exercise physiologists, physiatrists, physiotherapists, sports physicians and other specialists related to cardiovascular medicine, who from now on are challenged to explore this new technology for its efficient widespread use and employment in all patients who need it in our country.

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Figure 2. Assessment using ergospirometry for determining fitness degree and aerobic functional capacity of a high performance athlete prior to an international competition. He is a member of the national rowing team that won an important medal in a world tournament in Europe a few weeks later. In the picture we see that he is being assessed using a rowing simulator. A team coach and a specialist from our Center take part in the assessment.

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