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Cardiopulmonary exercise testing: current applications

Expert Rev. Respir. Med. 4(2), 179–188 (2010)

William W Stringer

Harbor-UCLA Medical Center,
Department of Medicine,
1000 W. Carson Street,
Box 400, Torrance, CA 90509,
USA

Tel: +1 310 222 2401

Fax: +1 310 320 9688

stringer@ucla.edu

wstringer@labiomed.org

Cardiopulmonary exercise testing (CPET) is under-utilized in assessing patients with prominent complaints of dyspnea or exercise limitation and should be one of the early tests used to assess exercise intolerance. The standard 12-lead ECG treadmill stress test focuses on coronary artery disease and is inadequate to assess the various subsystems (i.e., heart, lung, pulmonary vascular, peripheral vascular, muscle and psychological motivation) that can contribute individually, or more commonly in an interrelated fashion, to cause exercise limitation. The additional gas exchange information from CPET is very helpful in the identification of a more precise diagnosis, assessment of the severity of the impairment, determination of response to treatment and prediction of mortality. This special report will highlight some of the recent important applications of CPET to clinical medicine with specific references to heart failure, preoperative risk assessment, and regenerative and rehabilitative medicine, and the evidence that currently exists in the medical literature to support routine CPET use. It will also detail the recent evidence regarding the association of $\dot{V}O_{2\max}$ and survival in health and disease.

Keywords: cardiopulmonary exercise testing • dyspnea • exercise intolerance • heart failure • peak $\dot{V}O_2$ • preoperative risk assessment • ventilatory equivalents • $\dot{V}O_{2\max}$

Why order a cardiopulmonary exercise test?

Why should the clinician be interested in the type of exercise test that is ordered for his or her patient? Indeed, what expectations should the clinician have regarding exercise testing? In order to decide what type of exercise test a patient should perform, it is important to define what the goals for examination are. According to the American Thoracic Society (ATS)/American College of Chest Physicians (ACCP) consensus statement on cardiopulmonary exercise testing published in 2003, indications for cardiopulmonary exercise testing (CPET) include evaluation of exercise tolerance and intolerance, evaluation of patients with cardiovascular (e.g., heart failure, cardiac rehabilitation, transplantation and exercise prescription) and respiratory diseases (e.g., chronic obstructive pulmonary disease [COPD], interstitial lung diseases, pulmonary vascular disease, cystic fibrosis and exercise-induced bronchospasm), and some specialized clinical applications such as preoperative risk evaluation, exercise rehabilitation and exercise prescription (1).

CPET versus standard exercise ECG

To exclude coronary artery disease in a patient with typical or atypical chest pain complaints,

a standard 12-lead ECG on a graded treadmill protocol (which incrementally increases speed and treadmill inclination) should be adequate, as long as the resting ECG is normal and the patient has a moderate pretest probability of coronary artery disease. However, if the intervention is expected to diagnose the cause of dyspnea or exercise intolerance, particularly in order to identify what organ system is most responsible for the exercise limitation, then a CPET is indicated if routine history and physical laboratories, ECG, chest x-ray, and/or pulmonary function testing do not reveal a specific diagnosis.

Standard ECG treadmill testing can provide information on heart rate, blood pressure, ECG changes suggestive of ischemia or arrhythmias, and an estimation of the metabolic rate in metabolic equivalents (METs; as a proxy for actual metabolic rate). The CPET is advantageous as it can provide additional information to assist in diagnosis, including precise data on gas exchange and metabolic data (oxygen uptake [$\dot{V}O_2$], carbon dioxide output [$\dot{V}CO_2$], gas exchange anaerobic threshold [G_{AT}], minute ventilation [\dot{V}_E], ventilatory equivalents for oxygen [$\dot{V}_E/\dot{V}O_2$] and carbon dioxide [$\dot{V}_E/\dot{V}CO_2$]), oxygen pulse (O_2 pulse), oxygen saturation via pulse oximetry (O_2 Sat), end tidal O_2 and CO_2 ,

Exercise Testing Current Concepts And Recent Advances

Hussin A.Rothana



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