DOWNLOAD PDF MANUAL OF EXERCISE TESTING

Chapter 1 : Manual of Exercise Testing (ebook) by Victor F. Froelicher |

The new edition of the Manual of Exercise Testing is the perfect companion for the exercise testing laboratory. Filled with practical examples and diagnostic clues, this handy manual covers exercise testing for the main cardiovascular problems faced today.

Treadmill and cycle ergometer bicycle are the most frequently used test methods. Cycle ergometer is preferred in Europe, while treadmill testing is predominant in the United States. Metabolic equivalents METs can be used to estimate the energy cost of physical activity. One metabolic equivalent 1 MET is defined as the amount of oxygen consumed while sitting at rest and is equal to 3. Metabolic equivalents are used because the concept offers an easy way of expressing energy cost of any exercise. The energy cost is expressed as multiples of the resting metabolic rate. For example, 5 METs implies that the energy cost of activity is equal to five times the energy consumption at rest sitting. METs may be used to describe the functional capacity during exercise stress testing. Results of treadmill tests are typically described in METs, whereas energy expenditure during bicycle ergometry is typically expressed in kilopond meters per minute. Protocols for clinical exercise testing generally include an initial warm-up period at low workload , followed by a successive graded increase in work load. The increase in work load occurs with predefined time intervals. Treadmill speed varies from 1. Elevation of the treadmill i. Work intensity is genereally higher with treadmill testing, as compared with bicycle ergometry. However, treadmill testing requires that the subject is capable of running and there is a risk of falling. There are several exercise protocols for the treadmill. The most common ones are the standard Bruce protocol and the modified Bruce protocol. Modern equipment is sophisticated and may accommodate the resistance to the pedaling speed resistance increases at lower speed, and vice versa. Measuring blood pressure is easier on cycle than on the treadmill. Importantly, the ECG is easier to record and there are fewer artefacts on cycle as compared with treadmill. Exercise resistance is usually measured in Watts W. Resistance is then increased with 15 W for females and 15â€”30 W for males every other minute. Resistance can be increased faster for well-trained subjects. The total duration of the exercise test should be 7 to 10 minutes. By then the patient should have reached the maximum capacity. Although clinicians typically use Watts to judge exercise capacity and workload, it is possible to translate Watts to oxygen uptake in milliliters per minute using standardized tables. METs may be calculated by dividing oxygen uptake per minute with the product of 3. Hence, the cycle runs the risk of terminating the test prematurely before reaching the maximum oxygen uptake. The instructor may facilitate this by supporting and motivating the patient during the entire procedure. If the achieved workload is not sufficient, the reliability and thus usefulness of the test will be inadequate. Expected maximum heart rate according to age and sex. That male should therefore achieve a heart rate of beats per minute for the exercise test to be reliable. The reasons for this follows: Evaluation of the exercise stress test: These parameters are listed in the table below and discussed in detail in subsequent chapters. Patients with significant heart disease may deteriorate rapidly if complications, such as arrhythmias, occurr. Chest discomfort pain Presence of chest discomfort pain must be assessed repeatedly during the test. Severity of chest pain is graded from 0 no pain to 10 maximal pain. Leg fatigue graded from 0 none to 10 maximal. Maximal workload acheived and duration of the test Workload is expressed in METs, Watts, kpm, depending on protocol and test method. Heart rate acceleration is also noted. Deviation of the ST segment ST deviation is of primary interest. ST deviation indicates myocardial ischemia. The type of ischemia induced by exercise demand ischemia typically provokes ST segment depression, and rarely ST segment elevation. Additionally, arrhythmias and conduction disturbances may occurr and must be noted. Blood pressure reaction Systolic blood pressure is measured every other minute. It is also measured at termination of exercise and then every other minute during the recovery period. Automatic blood pressure monitor should not be used; measurements should be manual. Cause of termination If the exercise test is terminated prematurely, the cause must be noted. Note that the ECG machines detects ventricular extrasystoles premature ventricular beats and excludes them from the signal averaged ECG. A separate rhythm strip is always available so that the clinician can monitor the frequency of ventricular extrasystoles. ECG changes and their implications will be

discussed in detail in subsequent articles. The increased venous return will subsequently increase cardiac preload a greater blood volume is returned to the left ventricle. Increased preload causes increased workload on the myocardium of the left ventricle and that may provoke myocardial ischemia due to increased oxygen consumption in the myoardium. Some patients only display ischemic ECG changes during the recovery period. Termination criteria A plethora of studies conducted in the past few decades show that exercise stress testing is a safe procedure. The risk of complications is low, despite the fact that many participants have significant heart disease, including ischemic heart disease. Absolute termination criteria The exercise test should be terminated in each of the following scenarios: This limit is lower if the patient has an increased risk of bleeding e. Pronounced angina pectoris grade 5 or higher according to the visual analogous scale. Technical problems making ECG recording or blood pressure recording unreliable. ST segment elevation 1 mm or higher in leads without pre-existing significant Q-waves. In each of the scenarios listead below, one should consider terminating the test: Marked change in the electrical axis ECG. Multifocal premature ventricular beats extrasystoles. Frequent coupled premature ventricular beats.

Chapter 2 : ACSM's Guidelines for Exercise Testing and Prescription

Auto Suggestions are available once you type at least 3 letters. Use up arrow (for mozilla firefox browser alt+up arrow) and down arrow (for mozilla firefox browser alt+down arrow) to review and enter to select.

The changes in heart rate,blood pressure,respiration,and perceived level of exercise provide data that permit quantitative estimation of cardiovascular conditioning and function. Exercise tests provide an opportunity to observe a personduring exercise. By monitoring heart rate and blood pressure and continually observing the ECG, one can detect changes in the hemodynamic response and ischemic type ECG ST segment depression, and can detect and classify disturbances in heart rhythm and conduction associated with exercise. Isotonic dynamic exercise, defined as muscular contraction of large muscle groups resulting in movement, primarily provides a volume load to the left ventricle, and thecardiovascular response is proportional to the degree of the exercise. Maximum Oxygen Uptake When dynamic exercise begins, oxygen uptake by the lungs quickly increases. After several minutes,oxygen uptake usually remains relatively stable steady state at each intensity of exercise. During the steady state, the heart rate HR , cardiac output,blood pressure, and pulmonary ventilation are maintained at reasonably constant levels. Maximal oxygen consumption Vo2max is the greatest amount of oxgen a person can utilize while performing dynamic exercise involving large components of total muscle mass and represents the amount of oxygen transported and used in cellular metabolism. Vo2max is significantly related to age,gender,exercise habits,heredity, and clinicalcardiovascular status Maximum Vo2 is equal to maximum cardiac output times maximum arteriovenous oxygen aVo2 difference. Since cardiac output is equal to the product of stroke volume and heart rate HR ,Vo2 is directly related to HR. Myocardial OxygenUptake Myocardial oxygen uptake Mo2 is determined by intramyocardial wall tension left ventricular LV systolic pressure times end-diastolic volume, divided by LV wall thickness , contractility, and HR. Mo2 can be estimated during exercise testing by the product of HR and systolic blood pressure, called rate pressure product. In general there is a linear relation between Mo2 and coronary blood flow. During exercise,coronary blood flow increases as much as five fold above the resting value. A patient with obstructive coronary disease,however,may not have enough coronary blood flow to supply the metabolic demands of the myocardium during vigorous exercise, and as a consequence,myocardial ischemia occurs. As cardiac output increases with dynamic exercise,vasculr resistance decreases in active muscles but increases in tissues that do not function during exercise. Since flow to active muscles increases much more than arterial pressure, there is a significant decrease invascular resistance. Heart Rate Response An increase in HR due to a decrease in vagal outflow is an immediate response of the cardiovascular system to exerciseThis is rapidly followed by an increase in sympathetic outflow to the heart and systemic blood vessels, which contribute to the increase in HR Arterial Blood Pressure Response Systolic blood pressure increase with dynamic work as a result of increasing cardiac output,while diastlic pressure usually remains about the same or decreases slightly. Paients who develop hypotension during exercise frequently have severe heart disease; patients with aortic valvular disease can also exhibit a drop in systolic pressure. After maximal exercise, there is normally a decrease in systolic blood pressure,usually reaching resting levels in 6 mins. In some patients with coronary artery disease CAD , higher levels of systolic blood pressure, at times even exceeding peak exercise values,may develop in the recovery phase Figure When exercise is terminated abruptly, some healthy persons have precipitous drops in systolic blood pressure due to venous pooling. Figure shows the physiologic response to submaximum and maximum treadmill exercise based on tests of more than apparently healhy men aged 25 t0 Maximalrate-pressure product ranges from a 10th percentile value of 25, to a 90th percentile of 40, The arterial blood supply to the myocardium and to the other muscles and organs is usually adequate for the maximal perfusion requirement of which the organ is capable. If obstructive disease is present within a coronary artery, only minimal reduction in maximal blood flow will take place until the degree of arterial obstrution becomes quite advanced. The predictive importance of exertional myocardial ischemia is related to the intensity of cardiac activity at which the ischemia became apparent. In general, only physicians and other health professionals especially nurses familiar with normal and abnormal responses during exercise and

qualified in Advanced Cardiac Life Support have the cognitive skills needed to perform exercise tests on patients competently. Equipment,medications ,and personnel trained to provide cardiopulmonary resuscitation CPR must be readily available. Although exercise testing of patients is considered safe , there are reports of acute myocardial infarction and death related to the procedure. Several surveys confirm that up to 10 myocardial infarctions or deaths, or both, can be expected per 10, tests. The risk is greater in postmyocardial infarction patients and in those being evaluated for malignant ventricular arrhythmias. Figure lists absolute and relative contraindications to exercise testing Figure list three classes of complications secondary to exercise tests. Figure lists the general indications for exercise testing Good clinical judgement is imperative in determining indications for and contraindications to exercise testing. Whereas absolute contraindications are quite definitive, in select cases with relative contraindications,even submaximal testing may provide valuable information. The physician should be certain that the subject understands the procedure and acknowledges the risks. Good physician-patient communication about testing and its risks is essential. As stated in the American Heart Association Exercise Standards, exercise testing of patients should be performed under the supervision of a physician who is trained to conduct exercise tests and who is responsible for ensuring that the exercise laboratory is properly equipped and that the testing personnel are appropriately trained. The level or degree of supervision needed during a test is determined by the clinical state of the patient being tested. The physician should interpret data derived from testing, suggest further evaluation or therapy, and aid in providing effective and timely advanced CPR when necessary. A defibrillator and appropriate medications should be immediately available. Figure details safety measures for exercise testing. The degree of supervision of an exercise test can range from assigning monitoring of the test to a properly trained nonphysician i. The latter is ideal for testing patients for diagnostic or prognostic purposes and is a requirement for testing all patients at increased risk for an exercise-induced complication. A physician should be immediately available during all exercise tests on patients. Patient Preparation Preparatios for exercise testing include the following: The patient should be instructed not to eat or smoke for 2 to 3 h before the test and to dress appropriately for exercise. No strenuouos physical efforts shoulb be performed for at least 12 h before testing. Cessation of medications may,at times, be considered since some drugs interfer with exercise responses,complicating interpretation of execise testing. Most patients are tested on their medications. Specific questioning is important to detrmine which drugs have been taken so that the physician can be aware of possible electrolyte abnormalities and other effects. A brief history and physical examination should be done to rule out contraindications to testing or to detect important clinical signs such as murmurs, gallop sounds, pulmonary bronchospasm, or rales. Patients with a history of increasing or unstable angina or uncontrolled heart failure should not be have exercise testing until their condition stabilizes. A cardiac physical examination should indicate which patients have valvular or congenital heart disease,particularly adult patients with severe aortic stenosis,who generally should not undergo exercise testing. A detailed explanation of the testing procedure should be given,outlining risks and possible complications. The patient should be told how to perform the exercise test, and the testing procedure demonstrated. This is essential,particulaly in patients with known heart disease,since an abnormality or a change may contraindicate testing. Recording the ECG before starting the exercise test and after hypervehtilation at another time may be helpful in detecting false positive indeterminate ECG changes,particularly in women. Standing ECG and blood pressure should be recorded to determine vasoregulatory abnormalities, particularly ST depression. Protocols for clinical exercise testing should include an initial low load warm-up , progressive uninterrupted exercise with an adequate duration in each level, and a recovery period. The most popular treadmill protocol is the Bruce one. The advantages of the Bruce protocol include a seventh or final stage,which cannot be completed by most individuals, and its use in many published studies,which provides extensive data for comparison. Its disadvantages include large increments in work loads that make estimation of Vo2max less accurate. In addition, the fourth stage can be either run or walked,probably resulting in different oxygen costs. Some subjects are forced to stop prematurely because of musculoskeletal difficulties or inability to toleratethe high work load increments. Regardless of technique used,the optimum exercise testing protocol should last 6 to 12 min and should be adjusted to the type of patient being tested. Since there is strong evidence that the level of exercise required to produce ischemia is

the most important part of the exercise test result,the question arises of how the exercise test work load shall be selected. There is overwhelming agreement on use of a progressive increasing protocol beginning with a stage low enough to be tolerated by the" weakest" candidate for testing and ending with a stage sufficiently difficult to challenge "the fittest" candidate. Each stage should be long enough in duration for the subject to reach or closely approach steady state, and the the work increments from one stage to the next should be small enough topermit the desired degree of precision in estimating work capacity. The Bruce treadmill protocol is widely used figure Typical work output requirements for each stage in terms of oxygen consumption have been determined, and the range of stages is adequate both for sedendary individuals and athletes. To increase applicability, two easier stages may be added below Stage1 in order to accommodate virtually all ambulatory individuals. In order for measurements of of treadmill performance exercise time, or rate-pressure response to be directly related to the actual cardiac work involved, the subject must have reached or closely approached "steady state". This implies that if the subject continued to exercise at this intensity,cardiac output,HR,and other indices would stay essentially the same until the point of fatigue. Steady state attainment requires at least 3 min, and perhaps longer on the treadmill, and exercise times shorter than this will not yield a reliable reflection of cardiovascular capacity. Rather than assign a certain stage of exercise protocol as a goal for an individual,it is preferable to require the sibject to exercise progressively through the protocol until it becomes excessively uncomfortable or impossible to continue,i. Failure to attain an exercise tachycardia reasonably close to a predicted maximum may not provide an adequate indication of the degree of effort figure The designated target HR, however, may be maximal for some subjects ,beyond the limit of others, but submaximal for others. A test is considered maximal when the patient appears to give a true maximal effort point of bodily exhaustion or when other clinical end-points are reached. Indications for Terminating Exercise Testing Indications for discontinuing an exercise test include absolute and relative indications figure Some abnormal responses occur only in recovery after exercise. For maximum sensitivity, patients should be supine in the postexercise period. Monitoring of Blood pressure and ECG should continue for at least 6 to 8min after exercise. An abnormal ECG response occurring only in the recovery period is not unusual;these responses are likely not false positive unless the occur late in recovery. Mechanicaldysfunction andelectrophysiological abnormalities in the ischemic ventricle after exercise can persist from minutes to hours. A decrease in skin temperature,cool perspiration, and peripheral cyanosis during exercise may indicate poor tissue perfusion due to inadequate cardiac output with secondary vasoconstriction, and higher work loads are not encouraged. Neurological signs such as light-headedness or vertigo can also indicate inadequate cardiac output. Physical examination Cardiacexamination immediately after exercise canprovide information about ventricular functio. A percordial bulge or gallop rhythm can result from left ventricular dysfunction. A mitral regurgitant murmur suggests papillary muscle dysfunction related to transient ischemia. Exercise or Functional Capacity The maximal oxygen consumption V o2max is the best index of maximal exercise capacity. A decrease in maximum cardiac output may be a consequence of CAD, and exercise may be limited by either anginal pain or an acute reduction in LV output. An increase in LV diastolic filling pressure and increasing pulmonary artery pressure will also limit exercise. A normal exercise capacity does not exclude severe cardiac impairment. Mechanisms proposed to explain a normal exercise performance in such patients include increased peripheral oxygen extraction, preservation of chronotropic reserve, ability to tolerate elevated pulmonary wedge pressure without dyspnea, and increased levels of plasma norepinephrine at rest and during exercise. Exercise-induced hypotension also identifies patients at increased risk for ventricular fibrillation in the exercise laboratory. Figure illustrates normal and abnormal systolic blood pressure responses to exercise tests. A relatively rapid HR during submaximum exercise or recovery could be due to vasoregulatory asthenia, decreased vascular volume or peripheral resistance, prolonged bed rest, anemia, or metabolic disorders and, therefore, may not reflect intrinsic cardiac disease. This finding is also relatively frequent in patients soon after myocardial infarction or coronary artery surgery.

Chapter 3 : Exercise stress test (exercise ECG): protocols, evaluation & termination â€“ ECG learning

DOWNLOAD PDF MANUAL OF EXERCISE TESTING

The new edition of the Manual of Exercise Testing is the perfect companion for the exercise testing laboratory. Filled with practical examples and diagnostic clues, this handy manual covers.

Chapter 4 : Manual Of Exercise Testing, 2e - | SlugBooks

Filled with practical examples and diagnostic clues, this manual covers exercise testing for the main cardiovascular problems. Extensively covering testing and interpretation, and also including a section on exercise physiology to provide essential science background, it acts as a companion for the exercise testing laboratory.

Chapter 5 : Manual of Exercise Testing, 2nd Edition

The test assesses the person's overall function but, if the person's exercise capacity is reduced, does not tell which of the individual organs and systems (that is, the heart, lungs, muscles and bones, or other organs and systems) is the limiting factor.