Course Name : Bachelor of Physical Education

Year : IInd

Paper Name : Kinesiology and Physiology of Exercise

Paper No. Ist

Lecture No. 20

Topic no. : Prac. - 4

Lecture Title : Efficiencies Tests : Vital capacity and Expiratory Force Tests - I

Introduction

Hello and welcome to this special module on physical education. Today we will be discussing about the various efficiency tests that are being conducted to analyze the strength of a person's metabolic and physical endurance. Let's have a look.

Lung function tests check how well your lungs work. The tests can find lung problems, measure how serious they are, and check to see how well treatment for a lung disease is working.

The tests look at:

- How much air your lungs can hold.
- How quickly you can move air in and out of your lungs.
- How well your lungs put oxygen into and remove carbon dioxide from your blood.

Types of lung function tests include:

- Spirometry.
- Gas diffusion.
- Body plethysmography.
- Inhalation challenge test.
- Exercise stress test.
- You may also hear the tests called pulmonary function tests, or PFTs.

Lung function results are measured directly in some tests and are calculated in

others.

No single test can determine all of the lung function values, so more than one type of test may be done. Some of the tests may be repeated after you inhale medicine that enlarges your airways (bronchodilator).

Spirometry

Spirometry is the most common lung function test. It measures how much and how quickly you can move air out of your lungs. You breathe into a mouthpiece attached to a machine called a spirometer. The machine records your results.

Spirometry can measure many different things about the way you breathe. These include how much air you can exhale, how much air you can breathe in and out in 1 minute, and the amount of air left in your lungs after a normal exhale.

Gas diffusion tests

Gas diffusion tests measure the amount of oxygen and other gases that move through the lungs' air sacs per minute. These tests let you know how well gases are being absorbed into your blood from your lungs. Gas diffusion tests include:

Arterial blood gases: This test shows the amount of oxygen and carbon dioxide in your bloodstream.

Carbon monoxide diffusion capacity (also called DLCO): This test measures how well your lungs transfer a small amount of carbon monoxide (CO) into the blood. Two different methods are used for this test:

Single-breath or breath-holding method: You take a breath of air from a container. The air contains a very small amount of carbon monoxide. Measurements are taken as you breathe in.

Steady-state method: You do the same thing but measurements are taken as you breathe out.

Lung Function Tests

Body plethysmography may be used to measure:

Total lung capacity (TLC): This is the total amount of air your lungs can hold. For

this test, you sit inside a small airtight room. You breathe through a mouthpiece while pressure and airflow measurements are collected.

Residual volume (RV): This is the amount of air that remains in your lungs after you exhale as much as you can. For this test, you sit inside the booth and breathe while the pressure of the booth is monitored. You may need to breathe through a mouthpiece while you are in the booth.

Inhalation challenge tests

Inhalation challenge tests are done to measure how your airways respond to substances that may be causing asthma or wheezing. These tests are also called provocation studies.

During the test, you inhale increasing amounts of a substance through a nebulizer. This is a device that uses a face mask or a mouthpiece to deliver the substance in a fine mist (aerosol). Spirometry readings are taken to evaluate lung function before, during, and after you inhale the substance.

Exercise stress tests

Exercise stress tests look at how exercise affects your lungs. Spirometry readings are done after exercise and then again at rest.

Multiple-breath washout test

The multiple-breath washout test is done to check people who have cystic fibrosis. For this test, you breathe through a tube. First you breathe air that contains a tracer gas. Then you breathe regular air while the amount of tracer gas you exhale is monitored. Test results are reported as a lung clearance index (LCI). A high LCI value means that the lungs are not working well.

Why these tests are being done

Lung function tests are done to:

- Find the cause of breathing problems.
- Find certain lung diseases, such as asthma or chronic obstructive pulmonary disease (COPD).
- Check a person's lung function before surgery.

- Check the lungs of someone who is regularly exposed to chemicals or other things that can damage the lungs.
- Check how well treatments for lung diseases are working.

Spirometry

Spirometry assesses the integrated mechanical function of the lung, chest wall, and respiratory muscles by measuring the total volume of air exhaled from a full lung (total lung capacity [TLC]) to maximal expiration (residual volume [RV]). This volume, the forced vital capacity (FVC) and the forced expiratory volume in the first second of the forceful exhalation (FEV1), should be repeatable to within 0.15 L upon repeat efforts unless the largest value for either parameter is less than 1 L. In this case, the expected repeatability is to within 0.1 L of the largest value. The patient is instructed to inhale as much as possible and then exhale rapidly and forcefully for as long as flow can be maintained. The patient should exhale for at least six seconds. At the end of the forced exhalation, the patient should again inhale fully as rapidly as possible. The FVC should then be compared with that inhaled volume to verify that the forced expiratory maneuver did indeed start from full inflation.

Reduction in the amount of air exhaled forcefully in the first second of the forced exhalation (FEV1) may reflect reduction in the maximum inflation of the lungs (TLC); obstruction of the airways; respiratory muscle weakness; or submaximal expiratory force due to poor coaching, poor understanding, or malingering. Airway obstruction is the most common cause of reduction in FEV1. Airflow obstruction may be secondary to bronchospasm, airway inflammation, loss of lung elastic recoil, increased secretions in the airway, or any combination of these cause. Response of FEV1 to inhaled bronchodilators is used to assess the reversibility of airway obstruction, although it is now widely appreciated that a response showing a lack of a significant increase in FEV1 does not indicate the patient will not benefit clinically from bronchodilator therapy. A significant increase in the inspiratory capacity (IC) and/or vital capacity (VC) after bronchodilator therapy can occur even when the FEV1 fails to show a significant change.

Indications

Spirometry is used to establish baseline lung function, evaluate dyspnea, detect pulmonary disease, monitor effects of therapies used to treat respiratory disease, evaluate respiratory impairment, evaluate operative risk, and perform surveillance for occupational-related lung disease.

Contraindications

Relative contraindications for spirometry include hemoptysis of unknown origin, pneumothorax, unstable angina pectoris, recent myocardial infarction, thoracic aneurysms, abdominal aneurysms, cerebral aneurysms, recent eye surgery (within 2 weeks due to increased intraocular pressure during forced expiration), recent abdominal or thoracic surgical procedures, and patients with a history of syncope associated with forced exhalation. Patients with active tuberculosis should not be tested.

Patient care/preparations

Two choices are available with respect to bronchodilator and medication use prior to testing. Patients may withhold oral and inhaled bronchodilators to establish baseline lung function and evaluate maximum bronchodilator response, or they may continue taking medication as prescribed. If medications are withheld, a risk of exacerbation of bronchial spasm exists.

Interpretation

Interpretation of spirometry results should begin with an assessment of test quality. Failure to meet performance standards can result in unreliable test results. The American Thoracic Society (ATS) defines acceptable spirometry as an expiratory effort that has the following characteristics:

Pulmonary function tests require patients to successfully perform respiratory maneuvers in a standardized manner in order to obtain clinically meaningful results. Spirometry is perhaps the most technically and physically demanding. The patient is required to inhale as fully as possible, exhale with as much as force as possible, and continue their expiratory effort until they empty their lungs as completely as possible or are unable to continue.

The comments of the technologist administering the test can assist the interpreting

physician in determining if the results of a testing session that fail to meet some of the standards can still provide clinically useful data.

Characteristics of acceptable spirometry efforts are as follows:

- Starts from full inflation
- Shows minimal hesitation at the start of the forced expiration (extrapolated volume (EV) <5% of FVC or 0.15 L, whichever is larger)
- Shows an explosive start of the forced exhalation (time to peak flow no greater than 0.12 s)
- Shows no evidence of cough in the first second of forced exhalation

Meets one of three criteria that define a valid end-of-test: (1) smooth curvilinear rise of the volume-time tracing to a plateau of at least 1 second's duration; (2) if a test fails to exhibit an expiratory plateau, a forced expiratory time (FET) of 15 seconds; or (3) when the patient cannot or should not continue forced exhalation for valid medical reason.

More Interpretations

In patients that have significant loss of lung elastic recoil (pulmonary emphysema, COPD), spirometry may show negative effort dependence of forced expiratory flow. The effort that has the highest peak expiratory effort may produce a lower FEV1 because of the dynamic compression of the airways that results from the loss of elastic recoil support of airways that is characteristic of emphysema. In this circumstance, reporting the highest FEV1 coming from an effort with submaximal expiratory effort can lead to confusing results, particularly if a setting of assessing spirometric response to bronchodilators. Although not yet a spirometry acceptability standard, it appears that when reporting the FEV1 considering only efforts that have a time to peak flow (TPEF) less than or equal to 0.12 seconds helps eliminate this effect. This parameter can be displayed on the most laboratory-based spirometry testing systems.

Additionally, the two largest values for FVC and the two largest values for FEV1 in the same testing session should vary by no more than 0.15 L (0.1 L if the largest value is <1 L).

Inspection of the volume-time tracing aids in identification of early termination of

expiration by evaluating the presence of an expiratory plateau. In the absence of an expiratory plateau, a 12- to 15-second expiratory time ensures the quality of the FVC. Inspection of the start of the volume-time tracing can identify a hesitant start, which can result in a falsely low FEV1. Repeatability of the FVC and the FEV1 helps ensure that the results truly represent the patient's lung function. Attention should be focused on the repeatability of two key parameters: FVC and FEV1.

In the United States, normal values and lower limits of normal defined by Hankinson et al (the National Health and Nutrition Examination Survey [NHANES] III predicted set) has been recommended by the American Thoracic Society (ATS). These provide specific equations for whites, African Americans and Mexican Americans. If the patient belongs to another ethnic group, the predicted values and lower limits of normal provided for whites by Hankinson et al should be reduced by 12% by multiplying the predicted value by 0.88 before comparison with the patient's results.

In 2012, the Global Lung Initiative (GLI), a Task Force of the European Respiratory Society, published a report that provides normative values for males and females from aged 3-95 years across a wide range of ethnicities. The use of these predicted values for spirometry has been supported globally, including the endorsements from the European Respiratory Society, the ATS, the American College of Chest Physicians, the Thoracic Society of Australia and New Zealand, the Australian and New Zealand Society of Respiratory Science, and the Asian Pacific Society for Respirology. The report is in accordance with the previously published recommendations of the ATS that called for the elimination of using a fixed percent of predicted cut point to determine normality and a fixed lower limit of normal of the FEV1/FVC ratio to identify airway obstruction, both of which have been shown to result in significant misclassification of spirometry results.

Conclusion

Lung function tests check how well your lungs work. The tests can find lung problems, measure how serious they are, and check to see how well treatment for a lung disease is working.

The tests look at:

- How much air your lungs can hold.
- How quickly you can move air in and out of your lungs.
- How well your lungs put oxygen into and remove carbon dioxide from your blood.

Types of lung function tests include:

- Spirometry.
- Gas diffusion.
- Body plethysmography.
- Inhalation challenge test.
- Exercise stress test.
- You may also hear the tests called pulmonary function tests, or PFTs.

Lung function results are measured directly in some tests and are calculated in others.

No single test can determine all of the lung function values, so more than one type of test may be done. Some of the tests may be repeated after you inhale medicine that enlarges your airways (bronchodilator).

Spirometry

Spirometry is the most common lung function test. It measures how much and how quickly you can move air out of your lungs. You breathe into a mouthpiece attached to a machine called a spirometer. The machine records your results.

Spirometry can measure many different things about the way you breathe. These include how much air you can exhale, how much air you can breathe in and out in 1 minute, and the amount of air left in your lungs after a normal exhale.

Gas diffusion tests

Gas diffusion tests measure the amount of oxygen and other gases that move through the lungs' air sacs per minute. These tests let you know how well gases are being absorbed into your blood from your lungs. Gas diffusion tests include:

Arterial blood gases: This test shows the amount of oxygen and carbon dioxide in your bloodstream.

Carbon monoxide diffusion capacity (also called DLCO): This test measures how

well your lungs transfer a small amount of carbon monoxide (CO) into the blood. Two different methods are used for this test:

Single-breath or breath-holding method: You take a breath of air from a container. The air contains a very small amount of carbon monoxide. Measurements are taken as you breathe in.

Steady-state method: You do the same thing but measurements are taken as you breathe out.

Lung Function Tests

Body plethysmography may be used to measure:

Total lung capacity (TLC): This is the total amount of air your lungs can hold. For this test, you sit inside a small airtight room. You breathe through a mouthpiece while pressure and airflow measurements are collected.

Residual volume (RV): This is the amount of air that remains in your lungs after you exhale as much as you can. For this test, you sit inside the booth and breathe while the pressure of the booth is monitored. You may need to breathe through a mouthpiece while you are in the booth.

Inhalation challenge tests

Inhalation challenge tests are done to measure how your airways respond to substances that may be causing asthma or wheezing. These tests are also called provocation studies.

During the test, you inhale increasing amounts of a substance through a nebulizer. This is a device that uses a face mask or a mouthpiece to deliver the substance in a fine mist (aerosol). Spirometry readings are taken to evaluate lung function before, during, and after you inhale the substance.

Exercise stress tests

Exercise stress tests look at how exercise affects your lungs. Spirometry readings are done after exercise and then again at rest.

So in this episode we have seen various physical tests can be administered to a

person for his physical and metabolic endurance and with the help of instruments we can find whether that person has got that ability to a good athlete or not. I hope that the information that was provided was of some use to all of you. Thank you so much for watching.