Pulmonary Function Testing in the Evaluation of Patients with Allergic and Immunologic Disorders

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The Pulmonary Function Laboratory plays an important role in the evaluation of patients with respiratory diseases, including those that have diseases that occur on an allergic or immunologic basis. The American Thoracic Society (ATS) and European Respiratory Society (ERS) created a task force to standardize lung function testing and published a series of position papers that serve as the most current resource available on this subject [1–5]. Physicians performing pulmonary function studies should refer to these guidelines and use them as the standard methodology so as to be consistent with all laboratories in North America and Europe.

This issue will cover the performance of spirometry, lung volume measurements, the determination of the diffusing capacity that is also called transfer factor or carbon monoxide uptake, bronchoprovocation challenge, and a provocative discussion of the problems in the interpretation of the results of the studies.

Spirometry is a dynamic test that is best for measuring flow rates. The FEV_1 is a volume that is exhaled in 1 s and thus is a flow rate. The FVC is a volume and not a flow rate and is dependent on the total expiratory time, especially in patients with airway obstruction. Spirometry is an effort-dependent study, and it is necessary to have the patient blow out as hard and as fast as possible to get optimum results. Thus, the technician performing the test must be well trained. There are two types of spirometers. Volume displacement spirometers are those where air is expelled into the device and this moves a bellows or piston. This

motion is measured and provides the values used in patient evaluation. Volume displacement spirometers have the advantage of maintaining their calibration from day to day and week to week, although they do need to be regularly calibrated and checked for air leaks. The disadvantages of volume displacement spirometers are that they tend to be bulky and have moving parts that can be damaged. Thus, they are difficult to use in field studies. The other type of spirometer is an electronic device that measures airflow using a pneumotachygraph and then electronically converting the result into the various measurements used. They have the advantage of being small, lightweight, and have no moving parts. Their disadvantage is that electronic drift can occur and any material collecting on the screen in the pneumotachygraph will alter the values. They require more frequent calibration checks. The newer models have been devised to minimize these problems. Electronic spirometers are well suited for field studies. It is important that a calibrating syringe be available to check the calibration of all spirometers. These are usually 3-l syringes.

Lung volume measurements are essentially static procedures and are best for determining volumes. The two general methods employed are 1) gas dilution using an inert gas that does not cross the alveolar barrier such as helium or neon and, in the past, by nitrogen washout with collection of the expired gases and 2) thoracic gas volume that is determined by plethysmography or radiographic techniques. The gas dilution and nitrogen washout techniques are less accurate when there is poor distribution of the gas throughout the lung, as is seen in patients with chronic obstructive pulmonary disease and asthma. This is because the percentage of the inhaled marker gas varies from area to area in the lung and the sampled expired specimen is apt to underestimate the total lung capacity due to the overall uneven distribution of the tracer gas throughout the lung.

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The plethysmographic methods require relatively slow breathing cycles to allow the pressures of the gas in the lungs to equilibrate with the pressure at the mouthpiece where the measurements are made. If equilibration does not occur, then the total lung capacity can be overestimated. Calibration of the meters and of the plethysmograph in these methods is necessary to ensure accuracy. Lung volume measurements are determined relatively infrequently as compared to spirometry.

The single breath carbon monoxide diffusing capacity is a test that measures much more than just the crossing of oxygen (carbon monoxide is used as a surrogate for oxygen) in the test from the alveolus to the blood. It is a test that requires attention to detail, as many factors can influence the result. In asthma, the value is normal or even elevated, so a low value indicates that another disorder is influencing the result. Diseases that affect the lung parenchyma will usually lower the value [6].

Bronchoprovocation challenge testing is used to diagnose or rule out a diagnosis of asthma in circumstances where the clinical data are inconclusive. Usually, methacholine is used as the provoking agent in the USA, although other chemicals such as histamine are also used. For looking for specific etiologies of occupational asthma, one can use the suspected chemical or organic compound if these are available in a form suitable for testing, which is infrequently the case. Also, one can improvise. An example would be to compare the response to two different paints, one with toluene di-isocyanate and one without this chemical. An ATS committee has presented a method for the standardization of methacholine bronchoprovocation challenge testing [7].

Perhaps the most difficult aspect of pulmonary function testing is the interpretation of the results. Normal or reference values are available for comparisons between the patient and a reference population. There is a range of normality, but in the development of reference equations, 95% of a healthy population defines the lower and, in some cases, the upper limit of normal. However, these statistical methods result in making 5% of this population of healthy people abnormal. Thus, there is a “gray zone” between a normal and abnormal result. Ideally, a laboratory should use a healthy population from its own community as the reference values, but this is often hard to obtain, so published equations are used. What is even more difficult is the determination of a significant change between two studies. Patients with lung disease may have more than the

expected day-to-day variation in their values. Also, with aging, the values change, so this must be taken into account if several years have elapsed between studies. Few data are available for comparing two studies on the same patient for most diseases.

This issue of Clinical Reviews in Allergy and Immunology along with the ATS/ERS position papers and the ATS standardization of the methacholine challenge testing provide the reader with what is necessary to run a pulmonary function laboratory that will provide useful information in patient evaluation. Training the technician to perform these tests and to get the maximum effort from patients is vital to the laboratory's success. Also, frequent calibration of the equipment is necessary to ensure optimal results.

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