Pulmonary Function Tests for the Generalist: A Brief Review

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CME Activity

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Abstract

One of the frequent reasons patients see their primary care physicians is for the symptom of dyspnea. Among the objective tests to quantify this symptom is the pulmonary function test, which includes several different studies: spirometry with flow-volume loop, lung volumes, and diffusing capacity of lung for carbon monoxide. The results may indicate both respiratory and nonrespiratory disorders, including helping in the diagnosis of cardiac or neuromuscular diseases. This review, intended for the generalist, describes common findings of pulmonary function tests and provides a road map for interpretation.

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Dyspnea is one of the main reasons patients see primary care physicians, accounting for 1% to 4% of all visits.[1-3] An objective way to differentiate between the multiple causes of dyspnea (a highly subjective symptom) is to order a pulmonary function test (PFT), which assists in the identification and quantification of respiratory system abnormalities.[4] Pulmonary function tests can also identify disorders outside the respiratory system, including neuromuscular weakness and cardiovascular processes. In addition, measurement of pulmonary function allows for long-term monitoring of disease progression and response to therapy.[5]

A PFT may include several different studies, commonly spirometry with flow-volume loop, lung volumes, and diffusing capacity of lung for carbon monoxide (DLCO), though the individual clinician may decide which components of the test they need for their patient. Of note, each laboratory will provide special instructions to the patient before the test, though it is usually recommended that the patient not use inhaled bronchodilators or smoke tobacco on the day of the test.

This review discusses each component of the PFT and provides a basic guide to interpretation by using an illustrative case.

Mr Smith is a 50-year-old man who presents to his primary care physician with increased exertional dyspnea, rash, and muscle weakness for the past 6 months. He has not experienced such dyspnea before, so his physician orders a PFT. The test results are summarized in Table 1.

SPIROMETRY

The most basic and useful PFT is spirometry. It includes measurement of exhaled or inhaled air during forced maneuvers. The forced vital capacity (FVC) is the amount of air that can be forcefully expelled, beginning with the lungs completely full (at total lung capacity [TLC]) and blowing maximally until as empty as possible (at residual volume [RV]). The forced expiratory volume in the first second (FEV_1) is the amount expelled during the first second of the FVC maneuver. The ratio of FEV_1 and FVC (FEV_1/FVC) is used as an indicator of obstruction. The forced expiratory flow at 25% to 75% of the pulmonary volume was developed as an indicator of "small airway disease"; however, it is nonspecific. Many laboratories no longer report it, and we do not recommend using it for interpretation.

The graphic display from spirometry is typically called a *flow-volume curve* if it includes only expiratory flow or a *flow-volume loop* if it includes both expiratory and inspiratory maneuvers (for simplicity, the rest of this review refers only to the flow-volume loop).[6] The flow-volume loop provides important clues about the quality, acceptability, and reproducibility of the maneuver, which is determined by national standards and controlled by each individual laboratory. It can also indicate unusual abnormalities, such as obstructive lesions of the central airways. Inspiratory flows are disproportionately reduced by lesions of the upper (extrathoracic) airway. Conversely, lesions in the lower trachea and main stem bronchi primarily affect expiratory flows whereas a plateau on both the inspiratory and expiratory curves suggests a fixed lesion. Figure 1 illustrates common examples of flow-volume loops and associated abnormalities.[6]

The abnormal results of spirometry separate into 2 large classes of disorders: obstructive and restrictive. Obstructive disorders are suggested by a low FEV_1/FVC ratio, whereas restrictive disorders are suggested by a normal FEV_1/FVC ratio with a low FVC. The American Thoracic Society (ATS) and European Respiratory Society (ERS) define an *obstructive process* as a FEV_1/FVC ratio below the 5th percentile of the predicted value, often called the *lower limit of normal* (LLN).[7] Some, including the Global Initiative for Chronic Obstructive Lung Disease, define an *abnormal FEV_1/FVC ratio* as one below 0.70, or 70%.[8]

TABLE 1. Patient Pulmonary Function Test Results (in Liters)

Variable	Normal	LLN	Found	% Predicted	Found	% Change
TLC	6.53	5.38	4.18	64		
VC	4.03	3.16	1.80	45		
RV	2.19	2.86	2.38	109		
FVC	4.03	3.16	1.47	36	1.72	17
FEV_1	3.21	2.46	1.07	33	1.41	32
FEV_1/FVC	79.8	69.3	72.6	91	82.1	13
MVV	141	108	55	39		
DLCO (adjusted)	28.6	20.6	15.0	52		

DLCO = diffusing capacity of lung for carbon monoxide; FEV_1 = forced expiratory volume in the first second; FVC = forced vital capacity; LLN = lower limit of normal; MVV = maximum voluntary ventilation; RV = residual volume; TLC = total lung capacity; VC = vital capacity.

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