Pulmonary Function Tests: 
When to Order and How to Interpret

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Disclosure

- The speaker has nothing to disclose.

Objectives

- Review common clinical presentations and conditions where pulmonary function testing may be beneficial to enhance diagnosis and management.
- Discuss the foundational physiology and pathophysiology that determines pulmonary function and the interpretation of these tests.
- Interpret sample pulmonary function testing in conjunction with patient cases.
Pulmonary Function Tests (PFTs): Why Do Them??

• Aid in the diagnosis of patients with dyspnea, cough & wheeze
• Help to establish diagnoses in patients with abnormal chest images
• Help to establish diagnoses in patients with abnormalities in gas exchange
• Provide longitudinal data to guide treatment in patients with various pulmonary diseases
• Provide risk stratification in patients undergoing thoracic and extra-thoracic surgery

Components of PFTs

• Spirometry
• Measurement of Lung Volumes
• Determination of Diffusion Capacity for Carbon Monoxide ($DL_{CO}$)

Standardization of PFTs

• Equipment and personnel
• American Thoracic Society (ATS): Official statements of the ATS:
  https://www.thoracic.org/statements/pulmonary-function.php
• Different labs have different software!
• Lower limits of normal
• Patient effort
Lung Volumes and Capacities

Components of PFTs
- Spirometry
- Measurement of Lung Volumes
- Determination of Diffusion Capacity for Carbon Monoxide (DLCO)

Spirometry
- Measures the amount of air a person can breathe out, and the amount of time taken to do so
- Takes 10 - 15 minutes (3 reproducible maneuvers)
- Volume-time curve
- Flow-volume loop
- Helpful in detecting airflow limitation and obstructive lung disease, as well as suggesting restrictive lung disease
- Highly effort dependent
Spirometry

• FVC (forced vital capacity):
  maximum volume of air that can be exhaled during a forced maneuver

• FEV1 (forced expired volume in one second):
  volume expired in the first second of maximal expiration after a maximal inspiration; this is a measure of how quickly the lungs can be emptied

• FEV1/FVC:
  FEV1 expressed as a percentage of the FVC, gives a clinically useful index of airflow limitation
FEV1 = 4.1 L
(FEV1/FVC = 4.1/5.5 = 0.75)
FVC = 5.5 L

FEV1 = 2.3 L
(FEV1/FVC = 2.3/5.0 = 0.46)

Figure 1

Simple Spirometry
Volume-Time Curve

Restrictive Pattern
Normal
Obstructive Pattern
Spirometry: Flow-Volume Loops in Asthma
Demonstrating Nonobstructed Pattern & Reversal of Airflow Obstruction Following a Beta-Agonist
Diffusing Capacity

**Decreased $DL_{CO}$**
- Anemia
- Emphysema
- Interstitial Lung Disease
- Pulmonary Vascular Disease

**Increased $DL_{CO}$**
- In disorders resulting in increased hemoglobin in areas of intact ventilation (e.g., alveolar hemorrhage and polycythemia).
CASE

Mr. P is a 60 yo man who presents with shortness of breath and increased sputum production (2 teaspoons clear phlegm each morning). He reports breathlessness on exertion at 1 – 2 blocks flat walking/1 flight stairs. Breathlessness has worsened over the past several years. He has no prior respiratory related hospitalizations or ED visits and has no other significant PMH. His internist gave him albuterol several months ago and he uses it several times a week with some relief. He started smoking at age 15 and smokes 2 ppd.

CASE - continued

VS: BP 138/78; HR 88; RR 22; afebrile; BMI 21; O2 sat at rest = 94%
No acute distress
Cardiac exam unremarkable
Lungs – diminished breath sounds; prolonged expiratory phase; scattered end-expiratory wheezing
No peripheral edema; no clubbing
CASE

Mr. F is 65 yo man who presented to his primary care physician with dyspnea of 3 month’s duration. Symptoms had progressed gradually over that time and there was no cough, phlegm, wheezing, chest pain, palpitations or leg swelling. Heart and lung examinations are normal. Chest X-ray was normal and the patient’s resting oxygen saturation on room air was 97%. Office spirometry is pictured below.

CASE - continued

The patient was sent to the pulmonary function lab for determination of lung volumes, which were normal, and diffusing capacity, which was 50 percent of the normal predicted value.
CASE
Ms. T is a 24 yo woman who presents with complaints of cough and wheeze for approximately 1 year. She has no significant past medical history and denies nocturnal awakenings due to respiratory symptoms. She states that wind (cold or warm) triggers symptoms. She is in no acute distress, vital signs are normal and resting room air oxygen saturation is 98%. Lung examination is normal.

CASE
Mrs. S is a 46 yo woman never smoker who presents with dry cough and breathlessness on exertion for one year. She reports a 30# weight gain over the past several years. Lung examination reveals bibasilar crackles. Resting oxygen saturation on room air is 94%.
### Other Testing Available in the PFT Laboratory

- Exercise oximetry
- Irritant challenge testing with methacholine
- Measurement of maximal inspiratory and expiratory pressures
- Cardiopulmonary stress testing

### Other Tests

- Pulse oximetry during exercise (6 minute walk test)
  - A fall of > 4% (ending at a saturation below 93%) suggests significant desaturation; emphysema, interstitial lung disease, pulmonary vascular disease
- Inhalation challenge testing (for definitive diagnosis of asthma)
  - 20% fall in FEV1
References


