



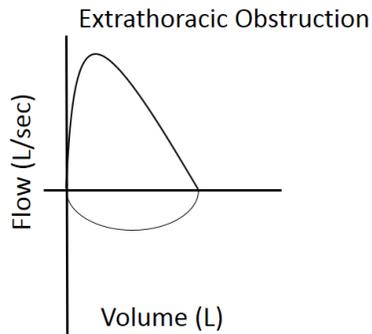
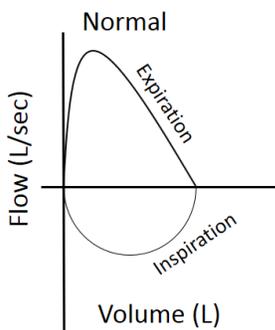
Pulmonary Function Testing

Pulmonary Function Testing (PFTs) are a group of breathing tests that show how the lungs are functioning. They are typically performed during diagnostic work up of patients with complaints of dyspnea and also on patients with a known diagnosis to track disease progression. PFTs measure total lung volumes, gas exchange and of particular interest in otolaryngology, air flow.

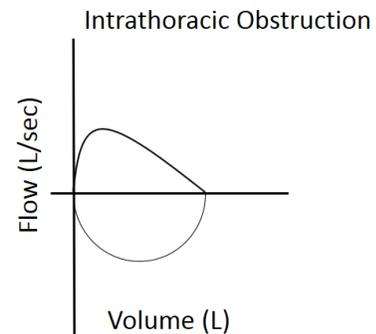
Flow Volume Loops

Spirometry is used with inspiration and forced expiration to create flow volume loops that can show obstruction (limited expiration), or restriction (limited inspiration). Below are some typical flow volume loops and their associated disease pattern.

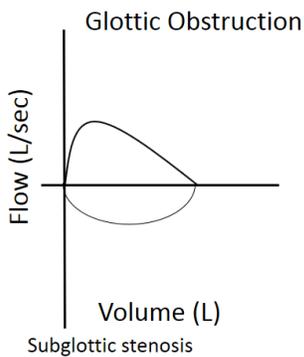
Volume loops:



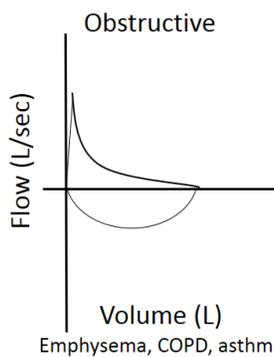
Supraglottic mass, vocal cord paralysis, paradoxical vocal fold motion



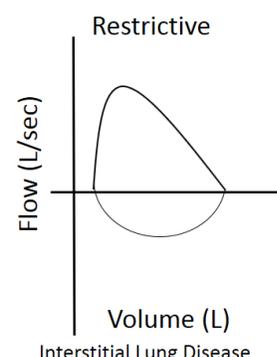
Tracheomalacia, tracheal mass



Subglottic stenosis



Emphysema, COPD, asthma



Interstitial Lung Disease



Airflow

Spirometry yields additional measurements including:

FVC: Forced vital capacity – This is the maximum volume of air exhaled with maximum effort following full inspiration. It is mainly used for calculating FEV_1/FVC ratio, but can be decreased in pleural or thoracic cage disease

FEV_1 : Forced expiratory volume in the first second of exhalation – This is the maximum volume of air exhaled in the first second of exhalation. Also used for calculating FEV_1/FVC ratio and also to track progress of obstructive lung disease such as COPD and emphysema.

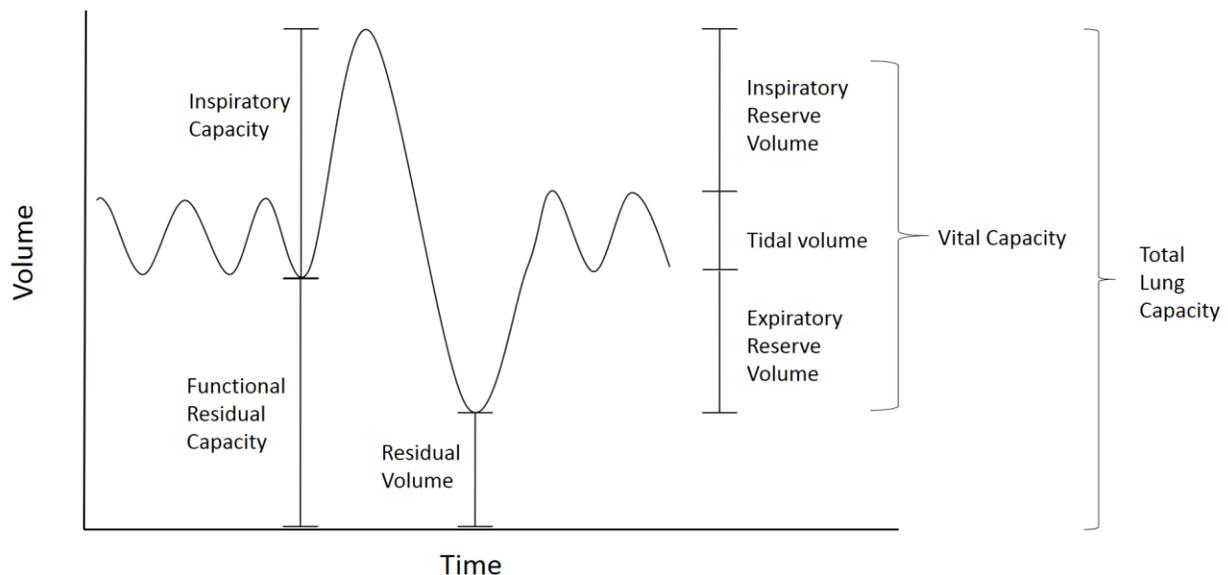
FEV_1/FVC ratio: Used to diagnose obstructive pulmonary disease such as COPD/emphysema. A value of 0.7 or less defines COPD.

PEF: Peak expiratory flow – Maximal rate of air flow during forced exhalation. Can be performed with small mechanical devices that patients can use at home to monitor changes in flow and assess any changes in their asthma control or laryngotracheal narrowing.

Lung Volumes

Lung volumes can be calculated with spirometry and by determining functional residual capacity (FRC) FRC can be found in several different ways; nitrogen washout, helium equilibration or body plethysmography.

Total volume:





Nitrogen washout: The patient inhales 100% oxygen and exhales into a one-way valve that measures the nitrogen content of the exhaled air. This can be used to extrapolate the residual lung volume as all of the nitrogen exhaled should be equal to 80% of the patient's total lung volume.

Helium equilibration: The patient inhales a mixture of helium and oxygen in a closed system until the concentration of helium is the same on inspiration and expiration indicating equilibrium. The total lung volume can then be extrapolated from the change in helium concentration.

Body plethysmography: The patient sits inside an airtight box. He or she is then asked to inhale against a closed tube. This expands the patient's chest and increases the air pressure within the box. The patient's lung volume can then be extrapolated using the changes in pressure and the box volume using Boyle's law ($P_1V_1 = P_2V_2$)

Gas Exchange

Gas exchange is a measurement of how well gas transfers from the alveoli into the blood. This can be measured with diffusing capacity for carbon monoxide (DLCO). Here, a patient inhales a small amount of carbon monoxide, holds his or her breath and then exhales and the end expiratory amount of CO is measured. This value can be decreased in pulmonary hypertension, pulmonary embolism or increased in heart failure and asthma.

Methacholine Challenge

Also known as bronchoprovocation testing, methacholine challenge is often used to diagnose asthma. During this test, patients perform a normal spirometry. They are then given nebulized methacholine (an acetylcholine derivative and bronchoconstrictor) in increasingly concentrated doses. Once the patient's FEV₁ drops to 20% of his or her normal value, the test is stopped. Usually a provocative dose or PD₂₀ of 8 mg/mL or less is considered a positive test.