CHAPTER-II

Pulmonary Function Test

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PFTs can be roughly divided into 5 basic components, spirometry, volumes, diffusing capacity, arterial blood gas, and flow-volume loops.

SPIROMETRY : The first component of a PFT report is spirometry which mainly provides a measure of flow. This defines whether or not the person is obstructed. We define obstruction as an FEV1/FVC ratio of less than the 5th percentile of the values obtained for normals.
LUNG VOLUMES:

- We define restriction (decreased lung volume) as a reduction in the total lung capacity (TLC) to values less than the 5th percentile of the predicted value for normals.

- DIFFUSION CAPACITY: In the simplest sense, the diffusing capacity is the ability of gas to cross from the air, across the interstitium, and into the blood. To measure diffusing capacity in the laboratory, we use carbon monoxide and measure the ability of the body to absorb carbon monoxide from a single breath (DLCO).
FLOW VOLUME LOOPS:
- The greatest value of the flow-volume loop is to assess for upper airway obstruction (for example, a laryngeal cancer)

PLETHYSMOGRAPHY:
- Plethysmography is an alternative means of measuring lung volume which is performed by having the patient sit in a closed box and measuring the degree of intrathoracic gas compression during inhalation and exhalation plus the amount of air displaced from the box during ventilation.
Lung Volumes and Capacities

- There are four basic lung volumes:
  - Inspiratory reserve volume (IRV)
  - Tidal volume (TV)
  - Expiratory reserve volume (ERV)
  - Residual volume (RV)

- In various combinations, these lung volumes then form lung capacities.

- E.g., Vital capacity = IRV + TV + ERV
Indications for Pulmonary Function Testing

- Patients 45 years old and older who have ever smoked.
- Patients with prolonged or excessive cough or sputum production.
- Patients with a history of exposure to lung irritants.
Indications for Pulmonary Function Testing

- Detecting pulmonary disease
  - Pulmonary symptoms – chest pain, orthopnea, cough, phlegm production, dyspnea, wheezing
  - Physical findings – Chest wall problems, cyanosis, clubbing, decreased breath sounds
  - Abnormal labs/x-rays – ABG, Chest X-Ray
Indications for Pulmonary Function Testing

- Assessing disease severity and progression
  - Pulmonary disease – COPD, Cystic fibrosis, Interstitial lung disease, Sarcoidosis
  - Cardiac disease – CHF, Congenital heart disease, Pulmonary hypertension
  - Neuromuscular disease – Amyotrophic lateral sclerosis, Guillain-Barre syndrome, Multiple sclerosis, Myasthenia gravis
Indications for Pulmonary Function Testing

- Pre-operative risk stratification
  - Thoracic surgery
  - Cardiac surgery
  - Organ transplantation
  - General surgical procedures
- Evaluating disability and impairment
Actual PFT Performance Technique

- Prepare the equipment – find a nurse who knows (or is that nose?) what to do.
- Patient should be seated with nose clip in place.
- The patient needs to practice the exercise before actually performing the test. Have the patient breath in and out deeply several times.
- Ask the patient to breath in as deeply as they can.
Actual PFT Performance Technique

- The patient should place their mouth completely over the mouthpiece, not inside it.

- Ask the patient to blow out as fast and as quick as they can for at least six seconds. Enthusiastically coach the patient – jump, shout, get down, hoot and holler…

  “Blow, blow, come on, blow more, you can do it!”
Actual PFT Performance Technique

- Once the patient has blown out as much as they can, ask them to then inhale as deeply as they can.
- Repeat the whole test three times. The goal is to get a reproducible result that is consistent.
- You may need to repeat the test more than three times in order to obtain an internally valid test.
Normal Values

- FVC is the total amount of air a person can exhale, usually measured in six seconds.
  - 80 – 120% of predicted is a normal value
  - 70 – 80% demonstrates mild reduction/restriction
  - 50 – 70% demonstrates moderate reduction
  - <50% demonstrates severe reduction

- FEV₁ is the amount of air a person can exhale in one second.
  - 80 – 120% of predicted is a normal value
Normal Values

- FEV$_1$/FVC ratio is the percentage of FVC that can be expired in one second.
  - 75 – 80% is normal
  - 60 – 80% demonstrates mild obstruction
  - 50 – 60% demonstrates moderate obstruction
  - <50% demonstrates severe obstruction
Normal Values

- $\text{FEF}_{25-75}$ reflects small airway function
  - $>80\%$ is normal
  - $60 - 80\%$ reflects mild obstruction in the small airways
  - $40 - 60\%$ reflects moderate obstruction
  - $<40\%$ reflects severe obstruction
Perform test
PFT Interpretation

Three steps in interpretation

- Is the test valid?
- Interpret the test
- Classify severity of disease if present
Validity

- The test is valid if you have good patient effort and the three tests performed are internally consistent.
- You may notice a learning curve in that the latter tests are better performed than the former.
- Make sure that the tests are maximal effort. You need to be really aggressive in coaching your patient.
PFT Interpretation

- Assess FVC, FEV$_1$, and FEV$_1$/FVC ratio.
- FVC and FEV$_1$ normal, with a normal FEV$_1$/FVC ratio:
  - Normal Test …
- FVC decreased, FEV$_1$ low or normal, and a normal to high FEV$_1$/FVC ratio:
  - Restrictive lung disease
- FVC normal or low, FEV$_1$ low, and a low FEV$_1$/FVC ratio:
  - Obstructive lung disease
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Restrictive Pattern
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Obstructive Pattern
Special Techniques

- Beta Agonist Challenge
- Methacholine Challenge
- DLCO
Beta Agonist Challenge

- Perform this when there is a suspicion that the obstructive defect may be reversible — asthma.
- Give the patient a beta agonist treatment (two puffs of an albuterol MDI or an albuterol nebulizer) and repeat the PFTs several minutes later. If you notice a 12% or more increase in FEV$_1$, then you have diagnosed reversible airway disease/asthma.
Diffuse capacity of carbon monoxide in the lung $DL_{CO}$

- After performing the standard PFTs, the patient then inhales trace amounts of carbon monoxide.
- CO traverses the alveolar capillary beds much more readily than CO$_2$ or O$_2$.
- As such, most of the CO inhaled should be absorbed.
- When it is not, this suggests pulmonary scarring consistent with pulmonary fibrosis. Search for a cause.
Methacholine Challenge

- If you have a suspicion that the patient might have exercise-induced bronchospasm (EIB), then refer them to a pulmonary lab where they can do provocative testing with methacholine.
- If the patient has a decrease in their FEV1/FVC ratio with the inhalation of methacholine, then you have diagnosed EIB.
- Pretreat before exercise with albuterol or cromolyn.
PFTs
THANK YOU