SPIROMETRY in GENERAL PRACTICE

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Would you manage hypertension without a sphygmomanometer???
Would you manage diabetes without a glucometer???
PEAK EXPIRATORY FLOW RATE (PEFR)

- Measures flow in large airways
- Of limited use in COPD
- Relationship between FEV1 and PEFR is poor in COPD (closer in asthma)
Spirometry measures airflow and lung volumes, and is the preferred lung function test in COPD.
SPIROMETRY in GENERAL PRACTICE

TERMINOLOGY

- FEV1 = the amount of air maximally exhaled in 1st second of exhalation
- FVC = the total volume of air that can be exhaled with maximum force, from maximum inhalation to maximal exhalation
SPIROMETRY in GENERAL PRACTICE

- FVC & FEV1 expressed as volumes (litres)
- Also expressed as % of predicted values
- Predicted values dependent on age, height, and gender.
- Ratio FEV1/FVC expressed as a percentage
Factors that influence normal values

- **Height** - tall people have larger lungs
- **Age** - Respiratory function declines with age
- **Sex** - Lung volumes smaller in females
- **Race** - Peculiarly studies show Blacks and Asians as a whole have smaller lung volumes (-12%) No studies for Maoris and Pacific People.
- **Posture** - little difference between sitting and standing. Reduced in supine position.
SPIROMETRY in GENERAL PRACTICE

**OBSTRUCTION**

- FEV1 / FVC < 70%
- FEV1 < 80% of predicted value
- In severe COPD the FVC may be < 80% predicted - Much less in fact
### Severity of Obstruction

<table>
<thead>
<tr>
<th>FEV1</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mild</td>
<td>&gt;70% Predicted</td>
</tr>
<tr>
<td>Moderate</td>
<td>50 - &lt; 69% Predicted</td>
</tr>
<tr>
<td>Severe</td>
<td>&lt;50% Predicted</td>
</tr>
</tbody>
</table>
Restriction

- Both FEV1 and FVC < 80% BUT the FEV1/FVC ratio is normal or high
### Severity of Restriction

<table>
<thead>
<tr>
<th>FVC</th>
<th>Mild</th>
<th>Moderate</th>
<th>Severe</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>&gt;65 - 80% predicted</td>
<td>&gt;50 - 65% predicted</td>
<td>&lt;50% predicted</td>
</tr>
</tbody>
</table>
Asthma

- Both FEV1 & FVC are reduced, but can demonstrate reversibility of at least 12%.
Flow / Volume Curve

- X axis represents volume
- Y axis represents flow rate
- Shape depends on mechanical properties of lung.
Flow / Volume Curve

Flow (L/sec)

Volume (L)

Pre
Post
SPIROMETRY in GENERAL PRACTICE

**Volume / time curve**

- Must be smooth
- Must plateau

ie Spirometry is only worth doing if it is done properly
Figure 2: Example of Spirometric Tracings and Calculation of FEV$_1$, FVC, and FEV$_1$/FVC Ratio

<table>
<thead>
<tr>
<th></th>
<th>FEV$_1$</th>
<th>FVC</th>
<th>FEV$_1$/FVC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>4.150</td>
<td>5.200</td>
<td>80%</td>
</tr>
<tr>
<td>COPD</td>
<td>2.350</td>
<td>3.900</td>
<td>60%</td>
</tr>
</tbody>
</table>

Patients with COPD typically show a decrease in both FEV$_1$ and FEV$_1$/FVC. The degree of spirometric abnormality generally reflects the severity of COPD. However, both symptoms and spirometry should be considered when developing an individualized management strategy for each patient.
SPIROMETRY

Spirometry in COPD of varying severity

- FEV1
- Volume (L)
- Flow rate (L/min)
- Time (s)
- Spirograms for Normal, Mild, Moderate, and Severe COPD
- Forced Vital Capacity (FVC) plateau can take > 12 s

Flow volume loop: single breath forced maneuver

- Inspiratory Flow Volume (L)
- Expiratory Flow Volume (L)
- Scooping
- Pneumotachograph: 'scooping' caused by expiratory airway collapse

Lung volumes

- Total Lung Capacity
- Inspiratory Reserve Volume
- Expiratory Reserve Volume
- Residual Volume

Natural history: decline in FEV1 with age

- FEV1 (% predicted at age 25 year)
- Disability
- Death
- Non-smoker or non-susceptible smoker
- Susceptible smoker (10–20%)
- Stopped smoking aged 50 years
- Stopped smoking aged 60 years

John, 42 years, is an area sales manager. “Chesty as a child” - Smoker - 10 pack years. He suffers from frequent “chest infections”.

Spirometry
FEV1 = 3.24 (76% pred)
FVC = 4.82 (91% pred)
FEV1/FVC = 67%

Post bronchodilator
FEV1 = 4.17 (29% improvement)
Brian - 65 yrs. Cough + SOB. Smoker 20 pack years

Spirometry

FEV1 = 1.67 (57% pred) Reduced
FVC = 2.07 (55% pred) Reduced
FEV1 / FVC = 81% Normal
Reversibility 6%
Rose 55 yrs. Smoker for 30 years - 45 Pack years. Increasing SOB. Smoker’s cough

Spirometry

FEV1 = 1.39 (56% pred) Reduced
FVC = 2.53 (86% Pred) Normal
FEV1/FVC = 55% Reduced
Reversibility = 5% Nil significant
Mel 50 years. Cough and SOB. Smoker 10 pack years.

Spirometry

FEV1 = 1.6 (60% pred) Reduced
FVC = 2.0 (70% Pred) Normal
FEV1/FVC 80% Normal
Post Bronchodilator 15% Reversibility
18 year old male
Presented with SOBOE
HX of childhood asthma
This prompted his office visit
Also has family HX of allergies
CASE #1: SPIROMETRY RESULTS

![Graph showing spirometry results with volume and flow axes. The graph compares pre and post results.](image-url)
# Case #1: Spirometry

<table>
<thead>
<tr>
<th></th>
<th>PRE</th>
<th></th>
<th>POST</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Meas.</td>
<td>%</td>
<td>Meas.</td>
<td>Change</td>
<td></td>
</tr>
<tr>
<td>FVC</td>
<td>5.35L</td>
<td>99%</td>
<td>5.67L</td>
<td>6%</td>
</tr>
<tr>
<td>FEV₁</td>
<td>3.84L</td>
<td>86%</td>
<td>4.60L</td>
<td>20%</td>
</tr>
<tr>
<td>FEV₁/FVC</td>
<td>71.8%</td>
<td></td>
<td>81%</td>
<td></td>
</tr>
</tbody>
</table>
CASE #1: Diagnosis

- Asthma
CASE #2: HISTORY

• 44 year old woman
• cc: fatigue with dry cough, SOBOE
• Past HX:
  • Ex-smoker
  • Chronic asthma
  • A few extrinsic allergies
• Family HX = positive for emphysema
CASE #2: SPIROMETRY RESULTS

Flow (L/sec)

Volume (L)
CASE #2: SPIROMETRY

<table>
<thead>
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<th></th>
<th>POST</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Meas.</td>
<td>%</td>
<td>Meas.</td>
<td>Change</td>
</tr>
<tr>
<td>FVC</td>
<td>4.65L</td>
<td>109%</td>
<td>4.85L</td>
<td>4%</td>
</tr>
<tr>
<td>FEV₁</td>
<td>2.60L</td>
<td>79%</td>
<td>2.80L</td>
<td>8%</td>
</tr>
<tr>
<td>FEV₁/FVC</td>
<td>56%</td>
<td></td>
<td>58%</td>
<td></td>
</tr>
</tbody>
</table>
CASE #2: Diagnosis And Treatment

• Query Moderate COPD
• Needs
  • Full PFTs
  • CXR
CASE #3: HISTORY

- 39 year old woman
- Smoker
- ++Extrinsic allergies
- SOBOE with white sputum x 1 week
CASE #3: HISTORY

- 3 visits to the ER in previous 2 days
- No previous measure of airflow (ie PEFR or Spirometry).
- Treated with Antibiotics
- Little improvement
- Family history is positive for asthma
CASE #3: SPIROMETRY RESULTS

Flow (L/sec)

Volume (L)

Pre
Post
## Case #3: Spirometry

<table>
<thead>
<tr>
<th></th>
<th>PRE</th>
<th>POST</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meas.</td>
<td>%</td>
<td>Change</td>
</tr>
<tr>
<td>FVC</td>
<td>1.75L 49%</td>
<td>2.50L 43%</td>
</tr>
<tr>
<td>FEV₁</td>
<td>1.10L 39%</td>
<td>1.50L 36%</td>
</tr>
<tr>
<td>FEV₁/FVC</td>
<td>63%</td>
<td>60%</td>
</tr>
</tbody>
</table>
CASE #3: Diagnosis

- Reversible obstruction
- Does not reverse to normal - Why?

Severe untreated asthma or COPD
CASE #4: HISTORY

- 32 year old man
- Recent pneumonia with persistent SOBOE
- No wheezing
- No sputum production
CASE #4: SPIROMETRY RESULTS

Flow (L/sec)

Volume (L)

Pre
Post
**CASE #4: SPIROMETRY**

<table>
<thead>
<tr>
<th></th>
<th>PRE</th>
<th>POST</th>
<th>Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meas.</td>
<td>%</td>
<td>Meas.</td>
<td></td>
</tr>
<tr>
<td>FVC</td>
<td>2.87L 52%</td>
<td>3.00L</td>
<td>5%</td>
</tr>
<tr>
<td>FEV₁</td>
<td>2.38L 56%</td>
<td>2.50L</td>
<td>5%</td>
</tr>
<tr>
<td>FEV₁/FVC</td>
<td>83%</td>
<td>83%</td>
<td></td>
</tr>
</tbody>
</table>
CASE #4: Diagnosis And Treatment: Moderate Restriction

- ? Further pulmonary function tests to confirm etiology
- Many potential causes
- This case: Restriction with decreased residual volume and Normal CO diffusion capacity
- Diaphragmatic eventration/paralysis due to old MVA
- Moral: Look at the x-Ray
CASE # 5: HISTORY

- 52 Year old woman
- SOBOE X 4 years
- Limited to walking less than 1 block
- No hemoptysis
- History of breast cancer
CASE #5: SPIROMETRY RESULTS

Flow (L/sec)

Volume (L)

Pre
Post
#### CASE #5: SPIROMETRY

<table>
<thead>
<tr>
<th></th>
<th>PRE</th>
<th></th>
<th>POST</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Meas.</td>
<td>%</td>
<td>Meas.</td>
<td>Change</td>
</tr>
<tr>
<td>FVC</td>
<td>1.36L</td>
<td>42%</td>
<td>1.92L</td>
<td>41%</td>
</tr>
<tr>
<td>FEV₁</td>
<td>0.60L</td>
<td>22%</td>
<td>0.86L</td>
<td>43%</td>
</tr>
<tr>
<td>FEV₁/FVC</td>
<td>44%</td>
<td></td>
<td></td>
<td>45%</td>
</tr>
</tbody>
</table>
CASE #5: Diagnosis And Treatment: COPD+/- Asthma

- CXR?
- Treat for asthma or COPD?
- Steroid trial?
- Pulmonary Rehab