Spirometry

- By Helen Grim M.S. RRT

Obstruction

- Loop will have concave appearance.
- Flows decreased consistent with degree of obstruction.
- Volumes may be normal, but can decrease with severity of obstruction causing air trapping. (FVC vs SVC)
Obstruction cont....

- Variable intrathoracic: affects expiratory flows
- Variable extrathoracic: affects inspiratory flows.
- Fixed obstruction affects both

TYPICAL RESTRICTION

- Simple restriction: curve is miniature of normal.
- Reduced VC
- Normal or increased FEV₁/FVC (FEV₁%)
- Increased elastic recoil of fibrotic lungs allows for increased flows.
- TLC is reduced in restriction... lung volume measurement is important
- Most often does not respond to bronchodilator.

Combined restriction/obstruction

- Patients may exhibit characteristics of both:
- Reduced volumes (confirmed by LV measurement) which don’t improve
- Also reduced flows which may or may not improve.

BASIC INTERPRETATION

<table>
<thead>
<tr>
<th>% of predicted</th>
<th>FVC, and FEV₁</th>
</tr>
</thead>
<tbody>
<tr>
<td>80-100%</td>
<td>Normal</td>
</tr>
<tr>
<td>&gt; 70%</td>
<td>mild</td>
</tr>
<tr>
<td>60-69%</td>
<td>Moderate</td>
</tr>
<tr>
<td>50-59%</td>
<td>moderately severe</td>
</tr>
<tr>
<td>35-49%</td>
<td>Severe</td>
</tr>
<tr>
<td>&lt; 35%</td>
<td>very severe</td>
</tr>
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</table>
**FEV₁/FVC or FEV₁%**
- The FEV₁% compares the amount of gas exhaled in the first second to the total amount exhaled.
- Normal adult lungs can exhale ~75% of its FVC in the first second.
- What would it indicate if the FEV₁% was 50%?
- What would it indicate if the FEV₁% was 85%?

**Basic Interpretation**
- Look at the FEV₁% ratio first if obstruction is suspected. If the FEV₁% ratio is lower than expected (the lower limit of normal), obstruction is present.
- If the ratio is normal or elevated, check the percent predicted for FVC and FEV₁. If FVC and FEV₁ are both reduced compared with the expected values, and FEV₁% is normal or high, restriction or muscle weakness may be present.

**Interpretation: Response to bronchodilator**
- Bronchodilators often administered to determine reversibility of obstruction.
- An increase of 12% or greater in FEV₁ is considered POSITIVE response to meds or 200ml improvement in FVC.
- Good med technique and appropriate wait time are important. 10-15 minutes for SABA.

**Lung Volumes**
- Tidal volume (Vₜ) - the volume from resting expiration to resting inspiration. Normal ~ 0.5L
- Inspiratory Reserve Volume (IRV) - the volume from resting inspiration to maximal inspiration. Normal ~ 3.1L
- Expiratory Reserve Volume (ERV) - the volume from resting expiration to maximal expiration. Normal ~ 1.2L
- Residual Volume (RV) - the volume left in the lungs after maximal expiration. Normal ~ 1.2L
Lung Capacities
- Inspiratory Capacity (IC) = $V_T + IRV$  Normal ~ 3.6L
- Vital Capacity (VC) = $V_T + IRV + ERV$ OR IC + ERV  Normal ~ 4.8L
- Functional Residual Capacity (FRC) = ERV + RV  Normal ~ 2.4L
- Total Lung Capacity (TLC) = sum of all volumes

Flowrates
- FEV_{1}, the volume of exhaled gas in a defined number of seconds from the start of an FVC maneuver
  - Four variants: FEV_{0.5}, 1, 2, & 3 seconds
  - Often reported only in mL or L, or that because the volume referred to is measured in a known amount of time—But because this is $\Delta V/\Delta T$, it is actually a flowrate

Peak Flow
- Normal ~ 10L/sec or 600 L/min
- Is the maximal flowrate attainable at any time
- On spiographic tracing, is measured as the tangent to the steepest slope of the spirogram
- Absolute accuracy is poor but good for “trend monitoring”

Forced Expiratory Flow 200-1200 (FEF_{200-1200})
- Aka MEFR (Mean Expiratory Flowrate)
- Normal ~ 400L/min
- Is the average flowrate after the initial 200mL is exhaled
- A more reliable index of airway’s condition (rather than patient effort)
- Tends to be sensitive (↓ values) to obstruction of the larger airways
Forced Expiratory Flowrate from 25% - 75% of volume (FEF_{25%-75%})

- aka Maximum Mid-expiratory Flowrate (MMFR)
- normal ~ 282L/min
- represents the average flow during the middle 50% of exhalation during the FVC maneuver
- a very reliable index of:
  - obstruction in medium to small airways (these are the sites most affected by asthma) or
  - chronic secretion diseases (e.g., chronic bronchitis and cystic fibrosis)

### Practice

<table>
<thead>
<tr>
<th></th>
<th>Meas.</th>
<th>Predicted</th>
<th>%Predicted</th>
</tr>
</thead>
<tbody>
<tr>
<td>FVC</td>
<td>1.33L</td>
<td>3.38L</td>
<td>39%</td>
</tr>
<tr>
<td>FEV_{1}</td>
<td>1.21L</td>
<td>2.36L</td>
<td>51%</td>
</tr>
<tr>
<td>FEV_{1}/FVC</td>
<td>aka FEV_{10}</td>
<td>91%</td>
<td></td>
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<table>
<thead>
<tr>
<th></th>
<th>Pre</th>
<th>Pred.</th>
<th>%</th>
<th>Post</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>FVC</td>
<td>2.30L</td>
<td>3.63L</td>
<td>63</td>
<td>2.45</td>
<td>67 (+4%)</td>
</tr>
<tr>
<td>FEV_{1}</td>
<td>1.12L</td>
<td>2.57L</td>
<td>44</td>
<td>1.30</td>
<td>51 (+7%)</td>
</tr>
<tr>
<td>FEV_{10}</td>
<td>0.59LPS</td>
<td>2.38LPS</td>
<td>25</td>
<td>0.83LPS</td>
<td>35 (+10%)</td>
</tr>
</tbody>
</table>

### Volumes

|       | Pre   | Pred. | % | |
|-------|-------|-------|---|
| VC    | 2.50L | 3.63L | 69|
| FRC   | 3.99L | 2.80L | 142|
| RV    | 3.13L | 1.91L | 164|
| TLC   | 5.79L | 4.82L | 120|
| RV/TLC| 54%   | 40%   |   |

### References