Factors Affecting Spirometry

- Setting standards
- Steps in Spirometry Interpretation
- Technical factors
- Biological factors
- Predication equations and reference values
- Concept of normality
“The clinical value of lung function tests is maximized when good quality tests are interpreted with appropriate reference values and appropriate interpretive schemes.”

ATS Statement Am Rev Respir Dis 1991
Steps in Spirometry Interpretation

- Acceptable & reproducible?
- Appropriate reference values?
- Any abnormality? Pattern and severity
- Differential diagnosis
Technical Factors

- **Instrument** (accuracy and imprecision)
- **Procedure** (Number of trials, Choice of results to be reported)
- **Observer** (Test administration, Evaluation of results)
- **Subject** (Comprehension, Cooperation, Effort, Illness)
- **Other** (Temperature, Altitude)
Biologic Variability

- **Intra-subject variation**
  - Effects of diurnal, circadian, and seasonal changes

- **Inter-subject variability**
  - Personal characteristics
    - body size, age, gender, physical activity, ethnicity
  - Environmental factors
    - smoking, occupation, residence, air pollution

- **Between-population variability**
  - study inclusion and exclusion factors
Reference Values

- Gender
- Age
- Body Size (height and weight)
- Ethnicity
What Value Is Abnormal

- **Prediction equations**
  - Limitations
  - Which equations to use

- **The normal range**
  - Predicted +/- 20%
  - The fifth percentile
  - The 95% confidence interval

- **Quantification of abnormality**
## Reference Equations Used: Example

### Female (age 18 – 70)
- FVC (L) \(4.43H - 0.026A^* - 2.89\)
- FEV1 (L) \(3.95H - 0.025A^* - 2.6\)
- FEV1/FVC (%) \(-0.19A^* + 89.1\)
- PEF (L/s) \(5.5H - 0.03A^* - 1.11\)
- FEF25-75% (L/s) \(1.25H - 0.034A^* + 2.92\)
- FEF50% (L/s) \(2.45H - 0.025A^* + 1.16\)

*For ages between 18 – 25, substitute ’25’ in equation.*

### Male (age 18 – 70)
- FVC (L) \(5.76H - 0.026A^* - 4.34\)
- FEV1 (L) \(4.3H - 0.029A^* - 2.49\)
- FEV1/FVC (%) \(-0.18A^* + 87.21\)
- PEF (L/s) \(6.14H - 0.043A^* + 0.15\)
- FEF25-75% (L/s) \(1.94H - 0.043A^* + 2.7\)
- FEF50% (L/s) \(3.79H - 0.031A^* - 0.35\)

*These equations are from ECCS 1993(update) references.*
Why Population-specific Reference Values?

- Most reference values derived from western populations
- Significant ethnic differences in normal pulmonary function values
- International guidelines recommend:
  - the use of population-specific reference equations
  - use recently developed equations
Reference Values for Omani Adults

Predicted lung function = \(a\) * age + \(b\) * height (cm) + \(c\)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Age (a)</th>
<th>Height (b)</th>
<th>Constant (c)</th>
<th>(R^2)</th>
<th>RSD</th>
<th>1.64*RSD</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Men</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>VC (l/min)</td>
<td>-0.024</td>
<td>0.048</td>
<td>-3.19</td>
<td>0.50</td>
<td>0.41</td>
<td>0.67</td>
</tr>
<tr>
<td>FVC (l/min)</td>
<td>-0.024</td>
<td>0.046</td>
<td>-2.97</td>
<td>0.48</td>
<td>0.41</td>
<td>0.67</td>
</tr>
<tr>
<td>FEV&lt;sub&gt;1&lt;/sub&gt; (l/min)</td>
<td>-0.021</td>
<td>0.034</td>
<td>-1.68</td>
<td>0.44</td>
<td>0.37</td>
<td>0.61</td>
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<tr>
<td>FEV&lt;sub&gt;1&lt;/sub&gt;/FVC (%)</td>
<td>-0.017</td>
<td>-0.123</td>
<td>105.21</td>
<td>0.02</td>
<td>4.98</td>
<td>8.17</td>
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<tr>
<td>PEF (l/sec)</td>
<td>-0.031</td>
<td>0.069</td>
<td>-1.87</td>
<td>0.15</td>
<td>1.35</td>
<td>2.21</td>
</tr>
<tr>
<td>MF25-75 (l/sec)</td>
<td>-0.033</td>
<td>0.017</td>
<td>2.32</td>
<td>0.17</td>
<td>0.83</td>
<td>1.36</td>
</tr>
<tr>
<td><strong>Women</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>VC (l/min)</td>
<td>-0.016</td>
<td>0.043</td>
<td>-3.27</td>
<td>0.46</td>
<td>0.38</td>
<td>0.62</td>
</tr>
<tr>
<td>FVC (l/min)</td>
<td>-0.016</td>
<td>0.043</td>
<td>-3.24</td>
<td>0.46</td>
<td>0.36</td>
<td>0.59</td>
</tr>
<tr>
<td>FEV&lt;sub&gt;1&lt;/sub&gt; (l/min)</td>
<td>-0.016</td>
<td>0.037</td>
<td>-2.68</td>
<td>0.47</td>
<td>0.32</td>
<td>0.52</td>
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<tr>
<td>FEV&lt;sub&gt;1&lt;/sub&gt;/FVC (%)</td>
<td>-0.075</td>
<td>-0.014</td>
<td>90.51</td>
<td>0.05</td>
<td>4.11</td>
<td>6.74</td>
</tr>
<tr>
<td>PEF (l/sec)</td>
<td>-0.013</td>
<td>0.075</td>
<td>-4.83</td>
<td>0.22</td>
<td>0.94</td>
<td>1.54</td>
</tr>
<tr>
<td>MF25-75 (l/sec)</td>
<td>-0.023</td>
<td>0.025</td>
<td>0.31</td>
<td>0.20</td>
<td>0.67</td>
<td>1.10</td>
</tr>
</tbody>
</table>

Normal Omani Subjects

% Predicted FVC

Oman | Pakistan | Jordan | ERS | USA

Males | Female

Normal Omani Subjects

% of below LLN

Males

Females

Normal Values: Omani Children

Summary – Minimizing the noise factors

- Select good instruments and maintain them carefully,
- Carefully adhere to ATS/ERS standards
- Select appropriate reference equations
- Select appropriate lower limits of the reference ranges,
- Use appropriate interpretive schemes
THANK YOU
Why Do We Need Spirometry?

- Objective Vital Sign for the Lungs
- Identifies and quantifies lung dysfunction
- Differential Diagnosis
- More Accurate Assessment of Severity
  - Early recognition of disease
  - Improves choice of therapy
- Determines Reversibility (Asthma vs. COPD)
- Assess response to treatment
- Reinforces therapeutic decisions to patients
- Monitors the time course of pulmonary dysfunction
- Pre-operative assessment
- Measures pulmonary disability
True or False

- Spirometry showing FEV1 < 80% of predicted and FEV1/FVC ratio <70% is diagnostic of COPD
- A spirometry showing an FEV$_1$ < 80% of predicted, FVC < 80% of predicted and FEV$_1$/FVC ratio of >70% is diagnostic of Pulmonary Restriction
- PC20
  - Negative test virtually excludes asthma
  - False positives post-infection
- A 44 year old Male is evaluated for nonproductive cough and progressive dyspnea.
- PFT results are as follows:
  - FVC = 3.14 L (63% of expected)
  - FEV₁ = 1.19 L (32% of expected)
  - FEV₁/FVC = 0.38 (51% of expected)