Assessment of the Lung in Primary Care

Andrew G Veale FRACP
NZ Respiratory & Sleep Institute
Auckland, New Zealand
Presentation

- Cough (productive or dry)
- Haemoptysis
- Shortness of breath / dyspnea
- Wheeze (or noisy breathing)
- Chest pain
- Finger Clubbing
- Abnormal lung function (spirometry screening)
- Abnormal radiology (CXR screening, CT for another purpose)
History

- Onset
- Timing
- Progression
- Associated symptoms
- Exacerbating factors
- Relieving factors
- Relationship to work/exposures/environment
- Family history
- Response to past treatments
Quantitate!

- How far can you walk on the flat before stopping?
- How many steps can you climb before stopping?
- What activities that you do every day, make you short of breath?
- Likeart scales
Examination

- Observation (Horners, SVC, Cyanosis)
- Clubbing
- Palpation (neck, axilla, breast, chest movements)
- Percussion
- Auscultation (crackles, wheeze, pleural rub)
Investigation

- **Diagnostic**
  - Chest radiography PA (lateral)
  - Spirometry (challenge testing)
  - Blood eosinophilia
  - Skin sensitivity
  - Avian precipitins

- **Severity assessment**
  - Spirometry
  - PEFR
  - Field exercise testing
Spirometry

- Normal Range
  - Population, Ethnic, LLN

- Validation
  - 3L syringe
  - Biological controls

- Staff training

- Ongoing QA
Spirometry Technique

- **Apparatus**
  - true spirometers - volume & time
  - pneumotach, vane & hotwire anemometers - flow

- **Method**
  - Full inspiration, forced maximal expiration
  - Minimum 3 technically acceptable attempts
  - Best 2 within 5% repeatability FEV₁ and FVC
    - Slow Vital Capacity may also be checked
Data generated

- Volume time curve (spirogram)
  - FEV1, FVC, Ratio
- Flow volume loop
  - Peak flow
  - FVC
  - FEF 25-75%
  - MEF 75, 50, and 25
  - Inspiratory flow data

NZ Respiratory & Sleep Institute
Auckland, NZ
Figure 3  Flow volume curve for a normal subject showing the principal measures used.
Normal distribution

$\phi_{\mu, \sigma^2}(x)$

- $\mu = 0, \sigma^2 = 0.2,$ blue
- $\mu = 0, \sigma^2 = 1.0,$ red
- $\mu = 0, \sigma^2 = 5.0,$ yellow
- $\mu = -2, \sigma^2 = 0.5,$ green

NZ Respiratory & Sleep Institute
Auckland, NZ
d  Variable Extrathoracic Obstruction

e  Fixed Obstruction (Intrathoracic or Extrathoracic)

f  Restriction
Purpose of LF tests

- Diagnosis
- Monitor progression of disease over time
- Test response to a drug short term
- Test response to a drug long term
- To assess impairment
- To assess surgical risks
When to order more complete Pulmonary Physiology Tests

- When spirometry doesn’t make sense
- When spirometry shows a low FVC and normal Ratio (restriction)
- When a challenge test is required
- When spirometry is normal in a symptomatic patient
- When you suspect an upper airway problem
- If a patient doesn’t respond as expected
- If there is a medicolegal / occupational issue
Physiology Tests

- Spirometry with Flow / Volume loops
- Static lung volumes TLC, FRC, RV
  - Body plethysmograph
- $D_LCO$ and $KCO$ (measure gas exchange)
- $FE_{NO}$
- Challenge testing (Histamine, Methacholine, Hypertonic Saline, Mannitol)
- CardioPulmonary Exercise Testing
- Hypoxic testing for flight safety
- Mouth pressure MIPS and MEPS (muscle weakness)
- Hypoxic/Hypercapnic ventilatory responses
Classification of COPD Severity by Spirometry

Stage I: Mild
- FEV₁/FVC < 0.70
- FEV₁ ≥ 80% predicted

Stage II: Moderate
- FEV₁/FVC < 0.70
- 50% ≤ FEV₁ < 80% predicted

Stage III: Severe
- FEV₁/FVC < 0.70
- 30% ≤ FEV₁ < 50% predicted

Stage IV: Very Severe
- FEV₁/FVC < 0.70
- FEV₁ < 30% predicted or FEV₁ < 50% predicted plus chronic respiratory failure

NZ Respiratory & Sleep Institute Auckland, NZ
ID: CSM4166
Date: 10/03/04
Gender: Male
Age: 62
Weight(kg): 79.0
Height(cm): 184
Temp: 23
BMI: 23.33

### Spirometry

<table>
<thead>
<tr>
<th></th>
<th>Ref</th>
<th>Pre Meas</th>
<th>% Ref</th>
<th>Post Meas</th>
<th>% Ref</th>
</tr>
</thead>
<tbody>
<tr>
<td>FVC</td>
<td>4.86</td>
<td>4.48</td>
<td>92</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FEV₁</td>
<td>3.38</td>
<td>(1.61)</td>
<td>(48)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FEV₁/FVC</td>
<td>70.0</td>
<td>(36.0)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FEF₂₅₋₇₅%</td>
<td>3.11</td>
<td>(0.35)</td>
<td>(11)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PEF</td>
<td>9.02</td>
<td>5.43</td>
<td>60</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Lung Volumes

TLC
RV
RV/TLC
FRC PL
ERV
VC

### Comments:
The patient could not fully expire during to FVC or SVC, therefore the results for both vital capacities may be underestimated. See attached FV loops
Variable extrathoracic

Fixed

Large airway obstruction
Measure

- Measure / Quantitate
- Measure again
- Measure repeatedly
- Buy good equipment
- HAVE GREAT STAFF (Dr’s are hopeless)
  - Train them properly
  - Treat them well
  - Monitor performance
- Develop a relationship with local Physiology Laboratory
Spirometry interpretation

- Obstructive v. Restrictive
- Mid flow obstruction
- Shape of the FV loop
  - Obstruction v. restriction
  - Fixed large airway obstruction
  - Variable airway obstruction
    - Extrathoracic
    - Intrathoracic
Airflow obstruction
Mild on left
Severe on right
Pulmonary restriction

NZ Respiratory & Sleep Institute
Auckland, NZ
ID: HLJ7135
Weight(kg): 61.0
PB: 753
Date: 04/08/04
Height(cm): 162
Temp: 22
Gender: Female
BMI: 23.24
Age: 83

Comments: Acceptable and repeatable results obtained.

Interpretation:
True or False?

A spirometry showing an FEV₁ < 80% of predicted, FVC < 80% of predicted and FEV₁/FVC ratio of >70% is diagnostic of Pulmonary Restriction.
Large Airway obstruction

- Tracheal
  - Fixed obstruction – expiratory and inspiratory limitation
  - Variable obstruction
    - Inspiratory limitation indicates extrathoracic obstruction
    - Expiratory limitation indicates intrathoracic obstruction
**Fixed Extrathoracic Obstruction PFT**

ID: CLV3379
Weight(kg): 82.0
PB: 765
Date: 22/03/01
Height(cm): 171
Temp: 25
Gender: Male
BMI: 28.04
Age: 30

<table>
<thead>
<tr>
<th>Spirometry</th>
<th>Ref</th>
<th>Pre Meas</th>
<th>Pre % Ref</th>
<th>Post Meas</th>
</tr>
</thead>
<tbody>
<tr>
<td>FVC</td>
<td>4.93</td>
<td>5.48</td>
<td>111</td>
<td></td>
</tr>
<tr>
<td>FEV₁</td>
<td>3.94</td>
<td>3.45</td>
<td>88</td>
<td></td>
</tr>
<tr>
<td>FEV₁/FVC</td>
<td>79</td>
<td></td>
<td>(63)</td>
<td></td>
</tr>
<tr>
<td>FEF₂₅-₇₅%</td>
<td>4.31</td>
<td>3.26</td>
<td>76</td>
<td></td>
</tr>
<tr>
<td>PEF</td>
<td>8.95</td>
<td>(3.83)</td>
<td>(43)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Lung Volumes</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>TLC</td>
<td></td>
</tr>
<tr>
<td>RV</td>
<td></td>
</tr>
<tr>
<td>RV/TLC</td>
<td></td>
</tr>
<tr>
<td>FRC PL</td>
<td></td>
</tr>
<tr>
<td>ERV</td>
<td></td>
</tr>
<tr>
<td>VC</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Resistance</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Raw</td>
<td></td>
</tr>
<tr>
<td>sRaw</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Diffusion</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>DLCO</td>
<td></td>
</tr>
<tr>
<td>DLCO /VA</td>
<td></td>
</tr>
<tr>
<td>VA</td>
<td></td>
</tr>
</tbody>
</table>

**Comments:** All tests were done well with good patient effort and technique and results were acceptable and reproducible.

**Interpretation:** Spirometry suggests obstructive pattern but flow loop consistent with fixed extrathoracic obstruction. Lung volumes and gas transfer preserved, making bleomycin lung disease unlikely. Does this subject have tracheal narrowing or an enlarged thyroid?.
Reversibility Interpretation

- **Definition of significant response**
  - FEV1 inc. by 15% AND 200ml
  - FEV1 or FVC inc. by 12% AND 200ml

- **What does reversibility mean?**
  - Reversible airflow obstruction
  - Asthma
  - COPD with reversibility
  - COPD + asthma
**Bronchodilator Response PFT**

**ID:** AKC1991  
**Date:** 21/06/04  
**Gender:** Male  
**Age:** 40  
**Weight (kg):** 96.0  
**Height (cm):** 189  
**BMI:** 26.87  
**Temp:** 21

### Spirometry

<table>
<thead>
<tr>
<th></th>
<th>Pre</th>
<th>Pre</th>
<th>Post</th>
<th>Post</th>
<th>Post</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Ref</td>
<td>Meas</td>
<td>% Ref</td>
<td>Meas</td>
<td>% Ref</td>
</tr>
<tr>
<td>FVC</td>
<td>5.71</td>
<td>6.05</td>
<td>106</td>
<td>6.31</td>
<td>110</td>
</tr>
<tr>
<td>FEV&lt;sub&gt;1&lt;/sub&gt;</td>
<td>4.27</td>
<td>3.74</td>
<td>88</td>
<td>4.27</td>
<td>100</td>
</tr>
<tr>
<td>FEV&lt;sub&gt;1&lt;/sub&gt;/FVC</td>
<td>74.0</td>
<td>62.0</td>
<td>68</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FEF&lt;sub&gt;25-75&lt;/sub&gt;%</td>
<td>4.19</td>
<td>(1.99)</td>
<td>(47)</td>
<td>2.66</td>
<td>63</td>
</tr>
<tr>
<td>PEF</td>
<td>10.27</td>
<td>10.19</td>
<td>99</td>
<td>9.4</td>
<td>91</td>
</tr>
</tbody>
</table>

### Lung Volumes

- TLC
- RV
- RV/TLC
- FRC PL
- ERV
- VC

### Resistance

- Raw
- sRaw

### Diffusion

- D<sub>LCO</sub>
- D<sub>LCO</sub>/V<sub>A</sub>
- V<sub>A</sub>

**Comments:** Acceptable and repeatable results obtained. Ventolin (2.5gm) was administered for bronchodilator testing.

**Interpretation:**
**Spirometry**

<table>
<thead>
<tr>
<th>Test</th>
<th>Ref</th>
<th>Pre Meas</th>
<th>Pre % Ref</th>
<th>Post Meas</th>
<th>Post % Ref</th>
<th>Post % Chg</th>
</tr>
</thead>
<tbody>
<tr>
<td>FVC</td>
<td>2.54</td>
<td>1.83</td>
<td>72</td>
<td>2.66</td>
<td>105</td>
<td>45</td>
</tr>
<tr>
<td>FEV₁</td>
<td>1.83</td>
<td>(0.76)</td>
<td>(41)</td>
<td>1.17</td>
<td>64</td>
<td>54</td>
</tr>
<tr>
<td>FEV₁/FVC</td>
<td>73.0</td>
<td>(41.0)</td>
<td>(44.0)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FEF₂₅₋₇₅%</td>
<td>2.26</td>
<td>(0.25)</td>
<td>(11)</td>
<td>(0.35)</td>
<td>(15.0)</td>
<td>41</td>
</tr>
<tr>
<td>PEF</td>
<td>5.15</td>
<td>2.36</td>
<td>46</td>
<td>3.64</td>
<td>71</td>
<td>54</td>
</tr>
</tbody>
</table>

**Lung Volumes**

- TLC
- RV
- RV/TLC
- FRC PL
- ERV
- VC

**Resistance**

- Raw
- sRaw

**Diffusion**

- D_LCO
- D_LCO / V_A
- V_A

**Comments:** Acceptable and repeatable results obtained. 2.5 mg of Ventolin was administered for 2 mins for bronchodilator testing.

**Interpretation:** Clinical details provided: COPD, ex smoker? reversibility. Spirometric lung volumes are indicative of a very significant degree of airflow limitation with more profound flow limitation at mid and low lung volumes. There is however a clinically important bronchodilator response.
Bronchial challenge testing -

- Often used for asthma diagnosis

- How?
  - Off inhalers
  - Check spirometry
  - Inhale a bronchoprovocator (histamine, methacholine, saline) at inc. concentrations
  - Measure spirometry after each inhalation

- N.B. exercise as a bronchoprovocator
Bronchial challenge testing – Data

- **PD20** = ‘Provocative Dose’ required to produce a 20% drop in FEV1
  - Histamine + if <4 micromol

- **PC20** = ‘Provocative Concentration’ required to produce a 20% drop in FEV1
  - Histamine + if <8 mg/ml

- **PC20/PD20** also used for Methacholine

- Hypertonic saline
### Histamine Dose Response

<table>
<thead>
<tr>
<th>ID: NDZ2751</th>
<th>Date: 16/12/03</th>
<th>Gender: Male</th>
<th>Age: 31</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight (kg): 81.5</td>
<td>Height (cm): 182</td>
<td>BMI: 24.60</td>
<td></td>
</tr>
<tr>
<td>PB: 7510</td>
<td>Temp: 23</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Histamine Response

<table>
<thead>
<tr>
<th>Histamine Response</th>
<th>Pre</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>Post</th>
<th>Post</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meas</td>
<td>%Δ</td>
<td>%Δ</td>
<td>%Δ</td>
<td>%Δ</td>
<td>%Δ</td>
<td>%Δ</td>
<td>%Δ</td>
<td>%Δ</td>
<td>%Δ</td>
<td>%Δ</td>
<td>%Δ</td>
<td>%Δ</td>
</tr>
<tr>
<td>FVC</td>
<td>6.48</td>
<td>-3</td>
<td>-2</td>
<td>-4</td>
<td>-14</td>
<td>-29</td>
<td>-30</td>
<td>-30</td>
<td>-30</td>
<td>-30</td>
<td>-30</td>
<td>-30</td>
</tr>
<tr>
<td>FEV1</td>
<td>4.82</td>
<td>-6</td>
<td>-8</td>
<td>-14</td>
<td>-29</td>
<td>-80</td>
<td>-80</td>
<td>-80</td>
<td>-80</td>
<td>-80</td>
<td>-80</td>
<td>-80</td>
</tr>
<tr>
<td>FEV1/FVC</td>
<td>74</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FEF25-75%</td>
<td>3.86</td>
<td>-9</td>
<td>-16</td>
<td>-31</td>
<td>-45</td>
<td>-45</td>
<td>-45</td>
<td>-45</td>
<td>-45</td>
<td>-45</td>
<td>-45</td>
<td>-45</td>
</tr>
</tbody>
</table>

**Comments:** Acceptable and repeatable results obtained. Histamine baseline Spirometry trials 5, 6, 7. Histamine test was positive with PD20 = 0.419. Ventolin (2.5 mg) was administered to release bronchoconstriction caused during bronchoprovocation challenge.

**Interpretation:** Baseline spirometry, static lung volumes and transfer factor are within normal limits. Bronchial challenge testing shows bronchoconstriction/airways hypersensitivity which is consistent with asthma in the appropriate clinical context.
Bronchial challenge – interpretation

- Threshold for positive may vary centre to centre
- Indicates ‘Bronchial hyperresponsiveness’
- Negative test virtually excludes asthma
- False positives post-infection
Static lung volumes

Why?

- Measure residual volume (and therefore TLC)

How?

- Measure the FRC
- Plethysmography or Gas dilution
- Plethysmography (bodybox) preferred
  - measures poorly ventilated airspaces
  - 2 types - volume-displacement & volume-constant
Volume-constant body plethysmograph
Lung volumes - interpretation

- True restriction - reduced TLC
- Hyperinflation - high TLC
  - Gas trapping - High RV, RV/TLC ratio
- Neuromuscular disease - ↓ TLC, preserved or raised RV
**Spirometry**

<table>
<thead>
<tr>
<th>Metric</th>
<th>Pre Meas</th>
<th>Pre % Ref</th>
<th>Post Meas</th>
<th>Post % Ref</th>
<th>Post % Chg</th>
</tr>
</thead>
<tbody>
<tr>
<td>FVC</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FEV&lt;sub&gt;1&lt;/sub&gt;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FEV&lt;sub&gt;1&lt;/sub&gt;/FVC</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FEF&lt;sub&gt;25-75%&lt;/sub&gt;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PEF</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Lung Volumes**

<table>
<thead>
<tr>
<th>Metric</th>
<th>Pre Meas</th>
<th>Pre % Ref</th>
<th>Post Meas</th>
<th>Post % Ref</th>
<th>Post % Chg</th>
</tr>
</thead>
<tbody>
<tr>
<td>TLC</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RV</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RV/TLC</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FRC PL</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ERV</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>VC</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Resistance**

<table>
<thead>
<tr>
<th>Metric</th>
<th>Pre Meas</th>
<th>Pre % Ref</th>
<th>Post Meas</th>
<th>Post % Ref</th>
<th>Post % Chg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Raw</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>sRaw</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Diffusion**

<table>
<thead>
<tr>
<th>Metric</th>
<th>Pre Meas</th>
<th>Pre % Ref</th>
<th>Post Meas</th>
<th>Post % Ref</th>
<th>Post % Chg</th>
</tr>
</thead>
<tbody>
<tr>
<td>D&lt;sub&gt;LCO&lt;/sub&gt;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D&lt;sub&gt;LCO&lt;/sub&gt;/V&lt;sub&gt;A&lt;/sub&gt;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>V&lt;sub&gt;A&lt;/sub&gt;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Comments:** The patient could not fully expire during forced and slow expiration, therefore the results were not quite accurate, even though they were repeatable.

**Interpretation:** Stable lung function.

---

NZ Respiratory & Sleep Institute Auckland, NZ
Transfer factor

Gas exchange by the lung depends on:

1. Ventilation of the airways and some air spaces by bulk flow of gas;
2. Mixing and diffusion of gases in the alveolar ducts, air sacs and alveoli;
3. Transfer of gases across the gaseous to liquid interface of the alveolar membrane;
4. Mixing and diffusion in the lung parenchyma and alveolar capillary plasma;
5. Chemical reaction with constituents of blood;
6. Circulation of blood between the pulmonary and systemic vascular beds.
**DL\textsubscript{CO} – Data generated**

- Then DL\textsubscript{CO} is calculated from the difference between ‘starting’ CO conc., and CO conc. after 10 sec in contact with alveoli.
- Expressed in ml/mmHg/min.
- \( V_A = \text{TLC by single breath helium dilution} \)
- \( \frac{DL\textsubscript{CO}}{V_A} = \text{transfer coefficient (}K_{CO}\text{)} \)

NZ Respiratory & Sleep Institute
Auckland, NZ
DL\textsubscript{CO} - interpretation

- DL\textsubscript{CO} ↓ by:
  - Pulmonary vascular diseases
  - Conditions affecting alveoli
  - Cardiac diseases
  - Anaemia
  - Pregnancy
  - Recent smoking
DL$_{CO}$ - interpretation

- $DL_{CO} \uparrow$ by
  - Polycythaemia
  - Pulmonary haemorrhage
  - L to R shunt
  - Exercise

- $K_{CO} (DL_{CO}/V_A)$
  - Corrected for volume. Theoretical function of the individual alveolus (??)
Other patterns

- **Obesity**
  - Restrictive Spirometry and TLC, very reduced FRC, reduced RV. DLCO only reduced in very gross obesity

- **Heart Failure**
  - Obstructive in Acute, Restrictive in Chronic with decreased gas transfer

- **Neuromuscular**
  - Decreased FVC, lower when supine, decreased TLC, preserved RV, preserved DLCO
Other tests to be aware of

- Airways resistance \( (R_{AW}) \) and conductance
  - In the plethysmograph
- Impulse oscillometry
  - Effort independent
  - Can identify site of obstruction

- Maximal Inspiratory and Expiratory pressures
  - Mouth pressures
  - Musculoskeletal disorders
Q6

- This flow-volume loop was produced by a patient with a history of Wegener’s Granulomatosis.
The most likely cause of the abnormality is

a. Cyclophosphamide therapy
b. Asthma
c. Pulmonary fibrosis
d. Extrathoracic tracheal stenosis
e. Intrathoracic tracheal stenosis
Pulmonary Physiology – Short version

- What sets FRC
- What sets FVC
- What dictates FEV$_1$
Indications

- Evaluate respiratory symptoms or signs
- Assess severity (Risk management / compensation)
- Assess response to an intervention
- Monitoring of disease progression
- Screening (opportunistic and systematic)
  - Smokers >20 pk yrs; Occupational groups; Certain drugs
- Practice
Lung diseases I

- **Obstructive Lung Disease**
  - Generalised
    - Asthma
    - COPD (Asthma, Bronchitis and Emphysema)
    - Bronchiectasis
    - Cystic fibrosis
  - Parenchymal
    - Emphysema
  - Major airways
    - FB, Neoplasm, Tracheal stenosis, tracheomalacia, vocal cord dysfunction
Lung Diseases II

- **Restrictive Pulmonary Disease**
  - Parenchymal thickening
    - ILD (IPF, asbestosis, CT disease, drugs, granulomatous, pneumoconiosis, pneumonitis etc)
  - Loss of functional lung tissue
    - Resection, atelectasis, large cancers
- **Pleural**
  - Effusion, fibrosis or tumour
- **Chest wall**
  - Kyphoscoliosis, neuromuscular diseases, rib trauma, ankylosing spondylitis
- **Extrathoracic**
  - Obesity and abdominal distention
ATS Acceptability & Reproducibility Criteria

- **Acceptability**
  - Good effort
  - No artifacts (coughing, glottic closure, leak)
  - 6 second exhalation with 2 second plateau
  - 3 acceptable maneuvers

- **Reproducibility**
  - Meets acceptability criteria
  - 2 largest FVC within 5% or 100mls
  - 2 largest FEV$_1$ within 5%

- **Reporting**
  - Report highest FEV$_1$ and FVC from any acceptable blow
  - Best test curve largest sum of FEV$_1$ + FVC
  - Take FEF$_{50\%}$ or FEF$_{25\%-75\%}$ from best curve
“Normal” Value

- Lung function varies with:
  - Height
  - Age
  - Sex
  - Race
  - Weight
  - Posture

- Population that the sample is taken from:
  - Cross section from the population
  - Cross section from the population without disease
  - Cross section from a population without disease and without known risk factors
Severity of COPD

- **FEV₁**
  - Normal: greater than 80%
  - Mild: 60% to 79%
  - Moderate: 40% to 60%
  - Severe: less than 40%

- **Asthma diagnosis**
  - FEV₁ improves 12% (15%) after bronchodilator
Equipment selection

- Meets ATS standards
- Simple to use and set up
- Easy to clean
- Acceptable output
- Nose clips not necessary
- Seated or standing
- Calibrate / Verify
- Biological control