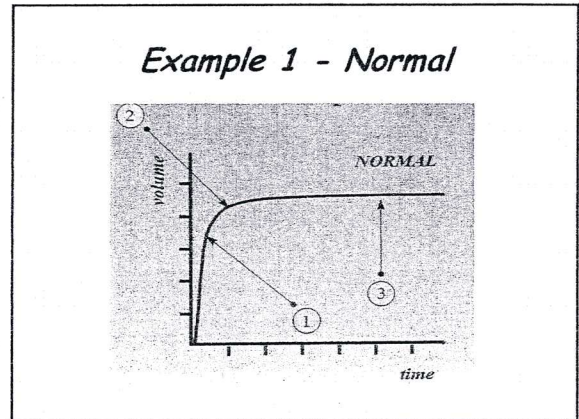
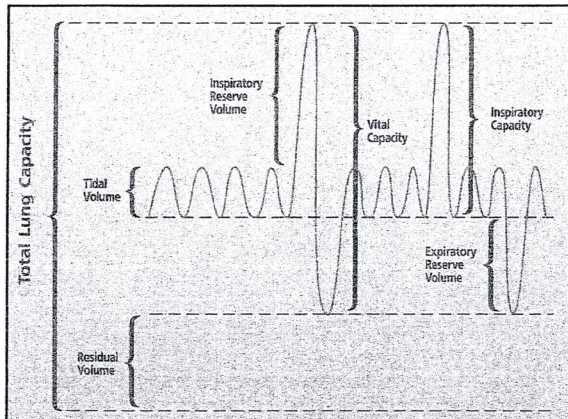
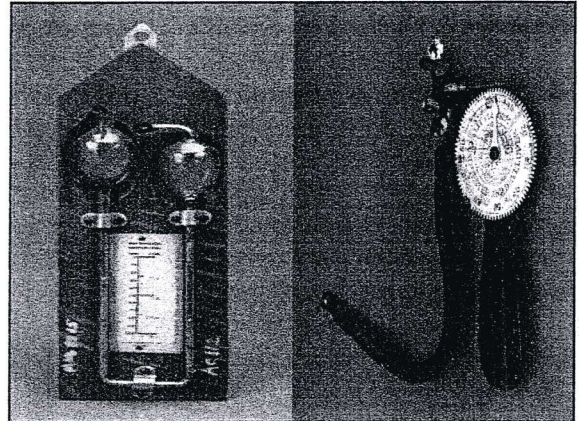
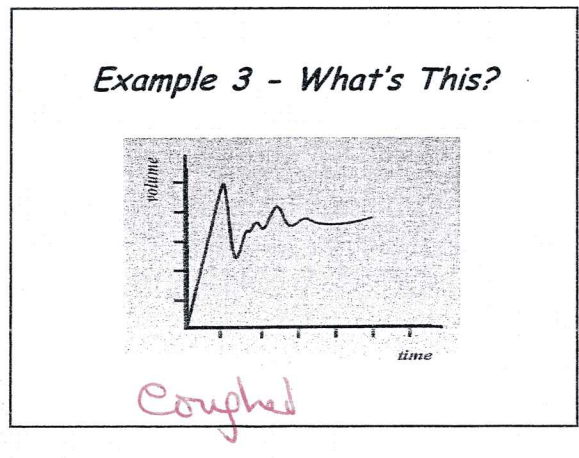
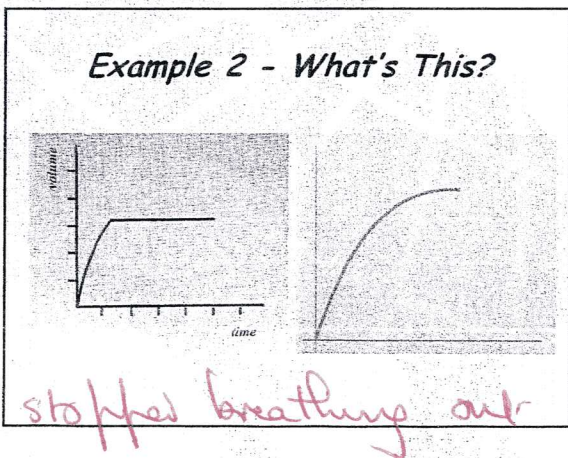


Making Sense of Spirometry

Sue Hunter
HealthCare Training Solutions

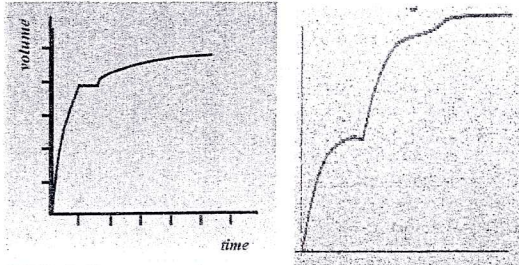


Residual Volume is ↑ in COPD
Air Trapping



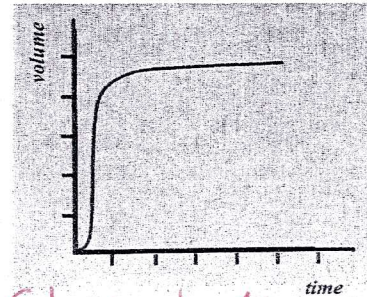
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Example 4 - What's This?



Took extra breath

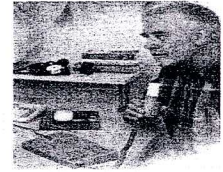
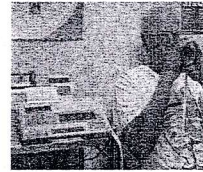
Example 5 - What's This?



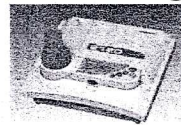
Slow start

How Do These Problems Affect Results Obtained?

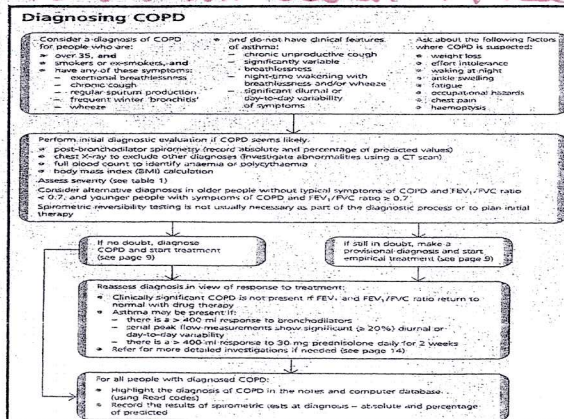
- | | |
|--|---------------------------------|
| 1. Slow start | 1. FEV ₁ , ratio |
| 2. Cough within 1 sec. of blow / later if interfered | 2. Possibly all |
| 3. Poor expiratory effort | 3. Possibly all |
| 4. Early termination of blow | 4. VC, FVC, ratio |
| 5. Air leaks around mouth | 5. Possibly all |
| 6. Unable to obtain 3 acceptable spiograms | 6. Test validity - possibly all |



Interpretation of Results: making sense of it all!



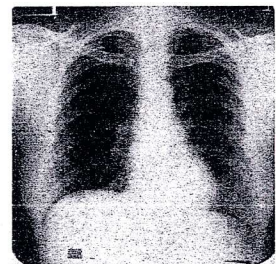
Do Bronchodilation in all




Use own puffer if has one

Spirometric Patterns

- ✓ Normal
- ✓ Obstructive
- ✓ Restrictive
- ✓ Mixed / Combined



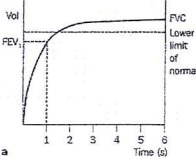



CPD Classifications

NICE (2010) has 4 stages:
mild, moderate, severe & very severe

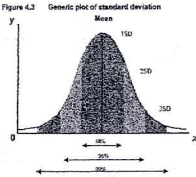
| NICE clinical guideline 12 (2004) | | ATS/ERS 2004 ³ | GOLD 2008 ⁴ | NICE clinical guideline 101 (2010) |
|---|------------------------------|---------------------------|------------------------------------|------------------------------------|
| Post-bronchodilator FEV ₁ /FVC | FEV ₁ % predicted | Post-bronchodilator | Post-bronchodilator | Post-bronchodilator |
| < 0.7 | ≥ 80% | Mild | Stage 1 - Mild | Stage 1 - Mild ⁵ |
| < 0.7 | 50-79% | Moderate | Stage 2 - Moderate | Stage 2 - Moderate |
| < 0.7 | 30-49% | Moderate | Stage 3 - Severe | Stage 3 - Severe |
| < 0.7 | < 30% | Severe | Stage 4 - Very severe ⁶ | Stage 4 - Very severe ⁶ |

⁵ Symptoms should be present to diagnose COPD in people with mild airflow obstruction
⁶ or FEV₁ < 50% with respiratory failure
ATS, American Thoracic Society; ERS, European Respiratory Society; FVC, forced vital capacity; GOLD, Global Initiative for Chronic Obstructive Lung Disease



Reference Ranges

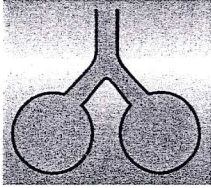
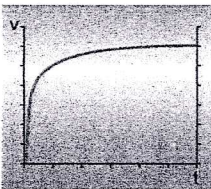
- ✓ Derived mathematically by using age & ht. to calculate pred. value & allow for some variation around that value (i.e. ref. 'range')
- ✓ Lung function measurements include 90% of general pop.
- ✓ Can often explain 'normal' results even if lower than 'standard' UK parameters
- * Data limited for children & adolescents (over-predict), elderly (under-predict) & non-Caucasian populations



Normal

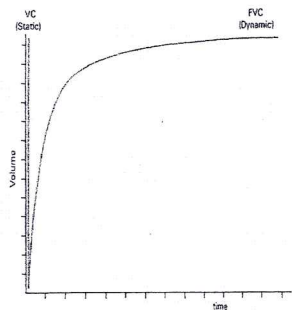
You will see:

- ✓ VC & FVC ≥ 80% pred.
- ✓ FEV₁ ≥ 80% pred
- ✓ ratio ≥ 70% (measured / base column)

VC vs. FVC

- ✓ Healthy subjects expel all air equally well ... whether forced or relaxed manoeuvre ... vol. measurements should be roughly equal
- ✓ FVC may sometimes be ↑ if more effort is put into this manoeuvre

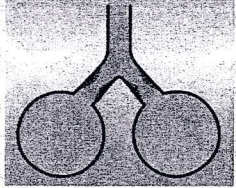
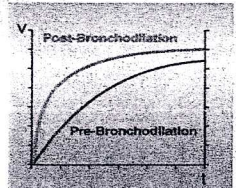


In obstruction lungs fill normally but empty slowly causing fall in FEV₁

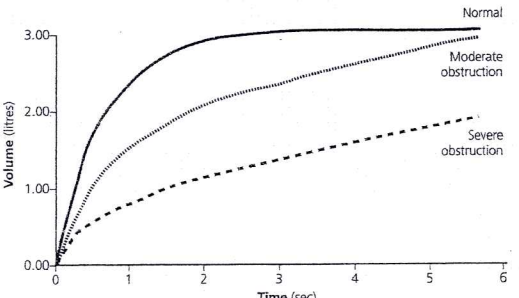
Obstruction

You will see:

- ✓ FVC normal (>80% pred.)
- ✓ FEV₁ ↓ (<80% pred.)
- ✓ ratio ↓ (<70%)

Varying Degrees of Obstruction



As lungs can empty OK the VC & FVC is OK

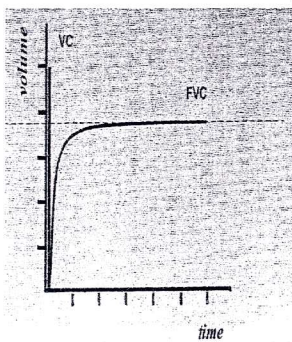
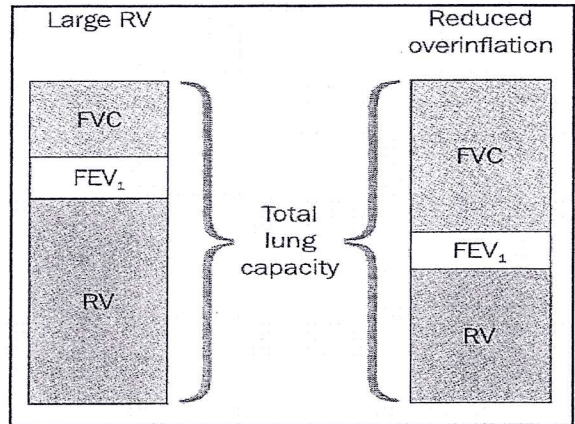
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Obstruction can be from COPD or from Asthma

Machine should show both $\frac{FEV_1}{VC}$ and $\frac{FEV_1}{FVC}$ Choose larger ratios

Air Trapping

- ✓ Some people have lower / smaller airway collapse - air is trapped distally & remains unmeasured
- ✓ Seen in severe COPD & emphysema

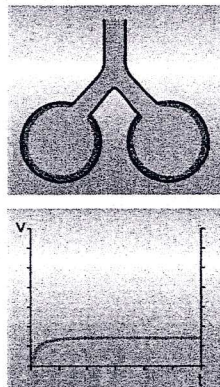
Needs a halo to measure residual volume

Can't stretch lungs

Restrictive (Small Lung) Disorders

- o Lung Parenchyma e.g. pulmonary fibrosis, pneumoconiosis, collapse, consolidation, oedema, fibrosing alveolitis, infection, sarcoidosis, infiltration, rheumatoid arthritis, previous surgery
- o Chest Wall Disorders e.g. scoliosis, ankylosing spondylitis
- o Neuromuscular Disorders e.g. Myasthenia Gravis, Guillain Barre, Duchenne MD, Poliomyelitis, Muscular Dystrophy
- o Pleural Diseases e.g. pneumothorax, pleural effusion, pleural thickening
- o Subdiaphragmatic conditions e.g. CCF, obesity, ascites, pregnancy

Restriction



You will see:

- ✓ FVC ↓ (<80% pred.)
- ✓ FEV₁ ↓ (<80% pred.)
- ✓ ratio 'normal' (≥70%)

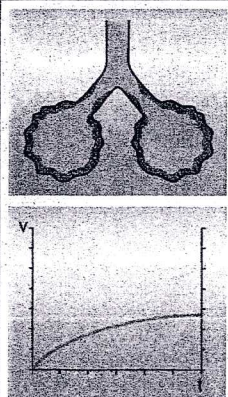
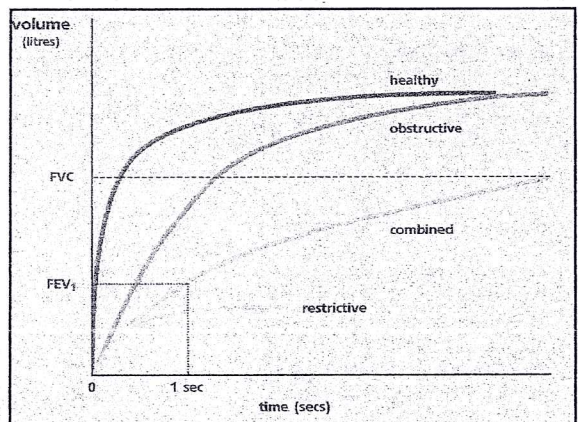
Tubes not narrowed so can blow out but not so much air to blow with → FVC ↓. Repeat to confirm then refer to chest clinic for further lung function tests

Mixed Pattern

(obstruction & restriction / very severe obstruction)

You will see:

- ✓ FVC ↓ (<80% pred.)
- ✓ FEV₁ ↓ (<80% pred.)
- ✓ ratio ↓ (<70%)



Now Look At Some Results...

What's This?

| | Predicted | Measured | % of Predicted |
|------------------------|-----------|----------|----------------|
| VC | | | |
| FVC | 5.2 | 5 | 96 |
| FEV ₁ | 4 | 3.9 | 98 |
| FEV ₁ /VC% | | | |
| FEV ₁ /FVC% | 77 | 78 | |
| FEF _{25-75%} | | | |

normal

Which Trace Is It?

What's This?

| | Predicted | Measured | % of Predicted |
|------------------------|-----------|----------|----------------|
| VC | | | |
| FVC | 3.7 | 2 | 54 |
| FEV ₁ | 3 | 1.8 | 60 |
| FEV ₁ /VC% | | | |
| FEV ₁ /FVC% | 81 | 90 | |
| FEF _{25-75%} | | | |

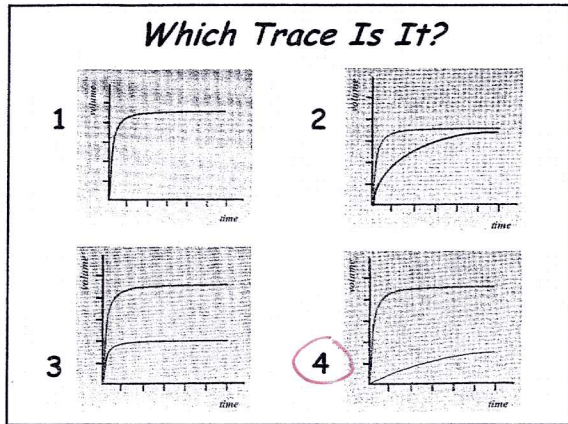
Restriction

Which Trace Is It?

What's This?

| | Predicted | Measured | % of Predicted |
|------------------------|-----------|----------|----------------|
| VC | | | |
| FVC | 2.61 | 1.5 | 57 |
| FEV ₁ | 2.08 | 0.5 | 24 |
| FEV ₁ /VC% | | | |
| FEV ₁ /FVC% | 76 | 33 | |
| FEF _{25-75%} | | | |

MIXED

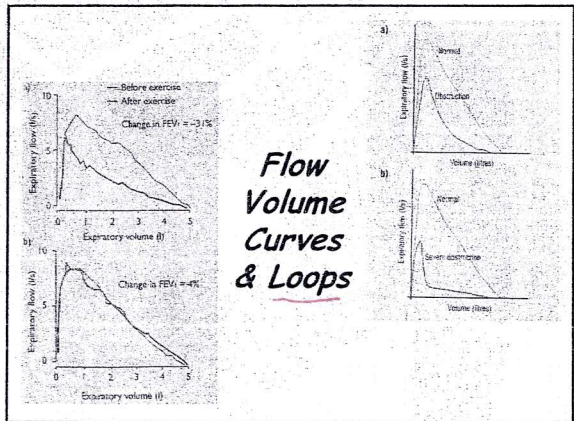
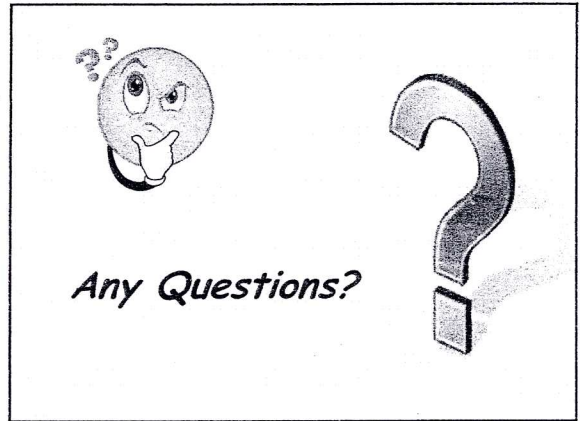
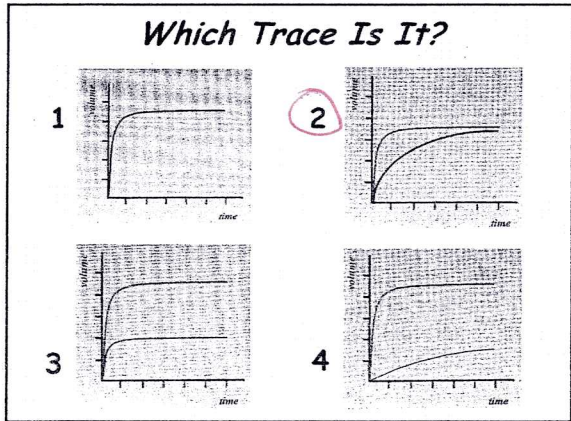


What's This?

| | Predicted | Measured | % of Predicted |
|------------------------|-----------|----------|----------------|
| VC | | | |
| FVC | 3.52 | 3.5 | 99 |
| FEV ₁ | 2.99 | 2 | 67 |
| FEV ₁ /VC% | | | |
| FEV ₁ /FVC% | 80 | 57 | |
| FEF _{25-75%} | | | |

Obstruction

ratio gives seventy - here mild



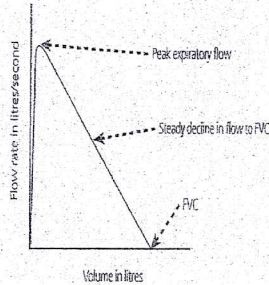
Flow Volume Curves

- ✓ Plot AIR FLOW i.e. rate at which air is expelled from all generations of airways ... & ... VOLUME of air expelled at that point
- ✓ Usually relates to patient's forced expiratory manoeuvre = expiratory flow vol. curve
- ✓ Very accurate in demonstrating upper airway obstruction (larynx & trachea)

Loops not available on all machines (measurements when breathing in)

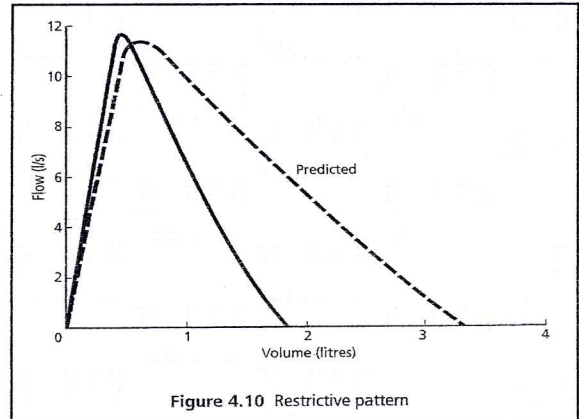
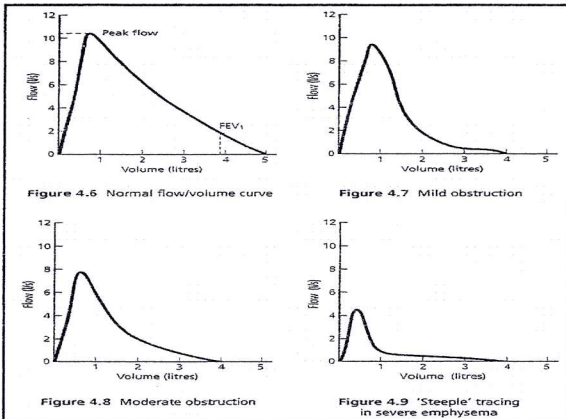
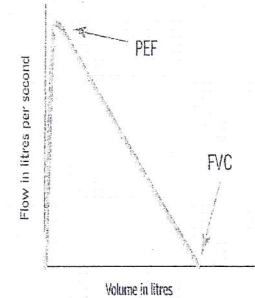
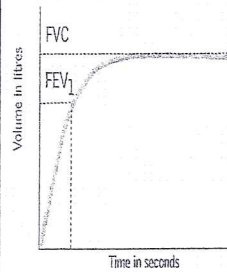
Flow Volume Curves

- ✓ Flow rate on vertical axis & volume on horizontal axis
- ✓ Rapid ↑ in flow at start - reaches peak quickly (PEF) - rapid ↓ in flow rate as forced expiration completed - curve drops to 0 (= FVC)



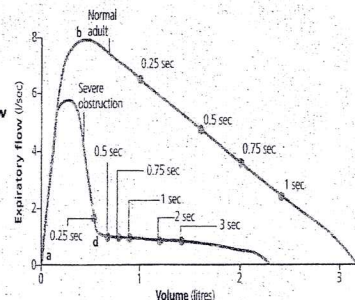
Volume/time. Smooth trace that reaches a plateau

Flow/volume. Rapid, almost vertical rise to peak expiratory flow (PEF); trace merges with baseline at forced vital capacity (FVC)



Forced (Max) Expiratory Flow Rate

- ✓ Known as FEF 25-75% / MMEF
- ✓ Measures air flow at mid point of blow i.e. between 25% & 75% of FVC
- ✓ Sensitive indicator of early airway changes
- ✗ (Cannot be done on volumetric machines e.g. bellows)



Examining Spirometric Results

1. Are patient details correct?
2. Has test met variability criteria? — Compare 3 trials
3. What does volume/time graph suggest?
4. What does flow/volume curve suggest?
5. What pattern do numerical values suggest?
6. If results support COPD - what is severity?
7. What action would you take now?
8. Any further comments to be noted? — ? systolic ? diastolic

FEV₂₅₋₇₅ (MMEF) measures small airways

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<50% = Pathology