# Interpretation of Pulmonary Function Tests

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## Spirometry & Flow Volume Loops

- an excellent first step in detecting changes in lung function
- simple & helpful in reaching a clinical diagnosis
- alone can not be expected to arrive at a diagnosis

## Spirometry & Flow Volume Loops

Is use to identify & quantify defects in respiratory system function

Can answer questions such as:

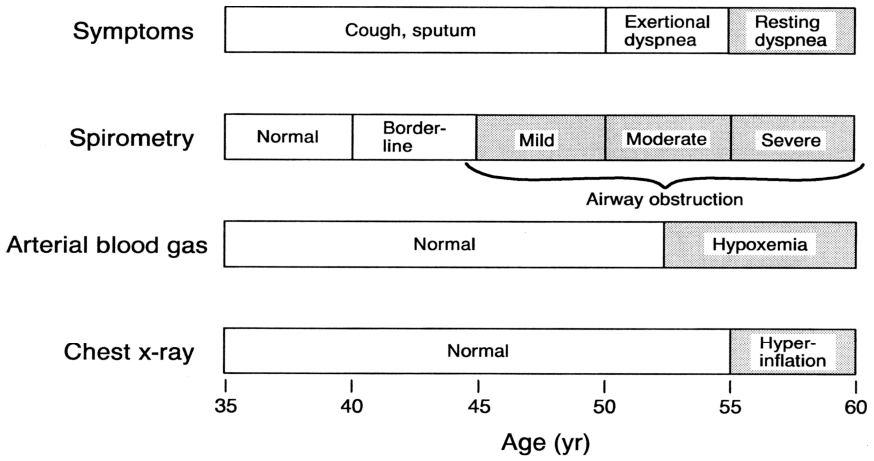
- Is there airflow limitation? How severe is it? Is there a response to bronchodilator therapy?
- Is there obstruction present along the major airways? Is it intra or extra thoracic?

## SPIROMETRY IS VASTLY UNDERUSED

**Family physicians do not order them enough**

- **Consider COPD in Canada-4th leading cause of death; 16 M in N. America**
- **Outstrips all other chronic conditions, ischemic heart disease, heart failure, diabetes, renal failure for hospital admissions & re admission $10,000/day, 10 day stay; about $1.5 billion/year**
- **Often mistaken for an acute isolated infection, bronchitis**
- **50% of cardiac patients also have COPD**
- **Prevalence among women on the rise (smoking/pollution)**
- **More women will die of COPD this year than breast cancer**
- **A look at progression of COPD makes it clear why a measure of lung function is so important in early diagnosis & treatment.**

## Progression of COPD Symptoms
### The Importance of Spirometry




## Dyspnea

- Few family physicians order lung function tests for patients who smoke or have mild to moderate dyspnea.
- Interesting that family physicians typically do check their patients blood pressure and do order CXR and ECG.
- Mind boggling that patients have had coronary angiography before spirometry tests to help identify the cause of their dyspnea!

## A PNEUMOTACHOGRAPH
### Measuring Air Flow as a Function of Lung Volume

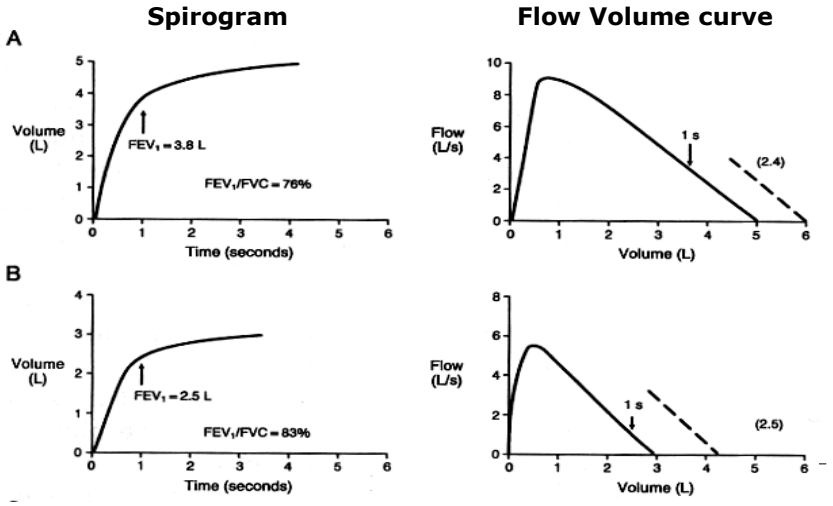
## Quantified Indices from a Vital Capacity Maneuver

- VC & subdivisions of lung volume [but not RV, FRC, TLC]
- FVC (L)
- $FEV_{\mathbf{1}}$ (L) [**>200ml or >15% improvement in response to bronchodilator therapy is an index of reversibility of air flow obstruction**]
- $FEV_{\mathbf{1}}/FVC$ **(%)** < 70% = obstructive defect
- Forced Expired Flows [e.g. $FEF_{\mathbf{50}}$; $FEF_{\mathbf{25\text{-}75}}$; PEF **(L/sec)]**

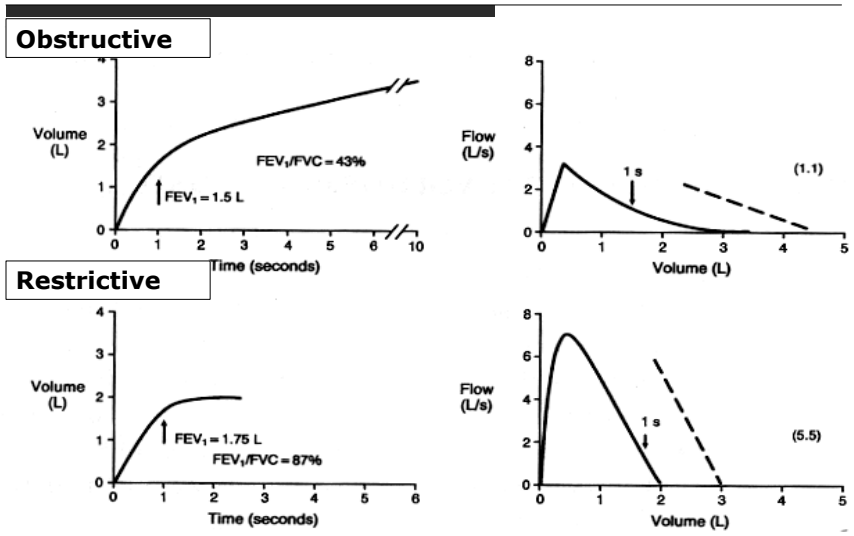
## Factors Determining Static Lung Volumes

- Height **taller individuals have larger lung volumes**
- Gender **males larger lung volumes than females**
- Age **childhood-lung volume increases with growth old age-increase in RV & FRC; decrease in ERV**
- Ethnicity **consider Asian, Black ancestry (-5 to -13%)**

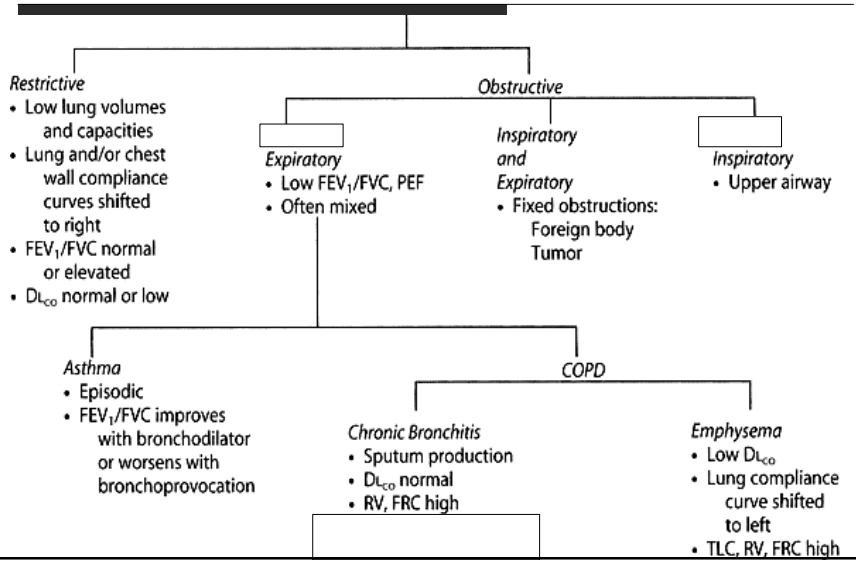
## Expiratory FVC Maneuver in Healthy Subjects



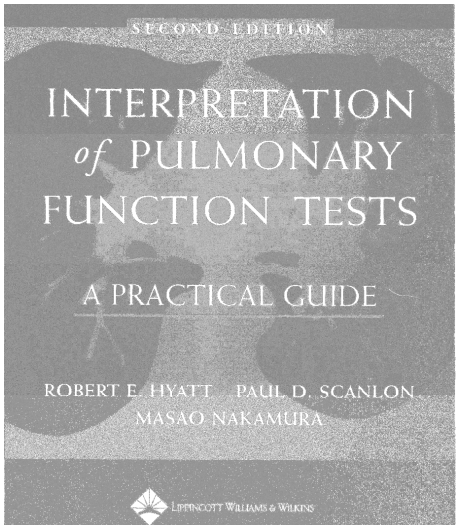
## Expiratory FVC Maneuver in Disease

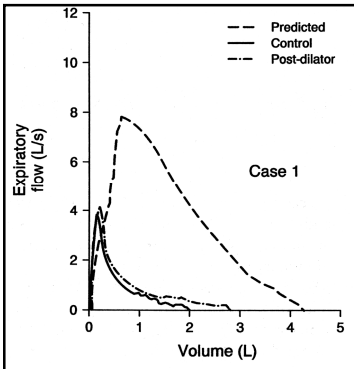



## Pulmonary Function Test Decision Tree



# ILLUSTRATIVE CASES FROM

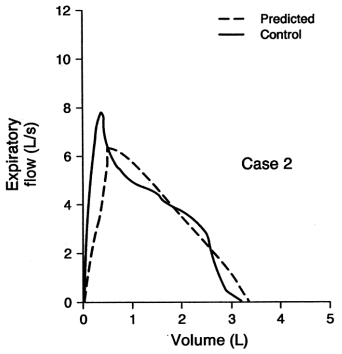



- severe obstructive ventilatory
- significant hyperInflation [↑ TLC & RV/TLC]
- small response to b/dilator.
- reduced DLCO = parenchymal abnormality; with hyperinflation suggestive of emphysema
- what other test(s) would provide further support for emphysema ?
- if instead of these results, TLC was very low & the slope of the curve was steep, what would these indicate?

71 y M Wt 195 lb (88 kg) Ht 69 in. (175 cm)

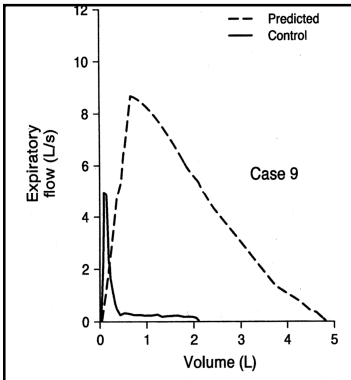
| | *Normal* | *Observed* | *% predicted* | *Post-dilator* |
|---|---|---|---|---|
| Spirometry | | | | |
| FVC (L) | 4.29 | 1.94* | 45 | 2.76 |
| $FEV_1$ (L) | 3.29 | 1.03* | 31 | 1.25 |
| $FEV_1$/FVC (%) | 77 | 53* | | |
| $FEF_{25-75}$ (L/s) | 2.8 | 0.4* | 15 | 0.5 |
| MVV (L/min) | 125 | 51* | 41 | |
| Volumes | | | | |
| TLC (L) | 6.61 | 9.37* | 142 | |
| RV/TLC (%) | 35 | 75* | 214 | |
| $D_{LCO}$ (mL/min/mm Hg) | 25 | 10* | 40 | |




- There is no ventilatory limitation
- The test values are all normal
- The atypical 'knee in the curve is a normal variant seen in n/smokers, especially women

36 y F Wt 183 lb (83 kg) Ht 64 in. (162 cm)

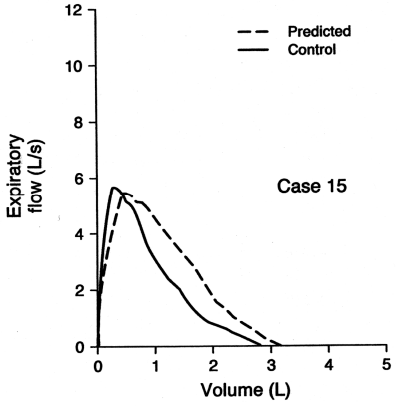
| | *Normal* | *Observed* | *% predicted* | *Post-dilator* |
|---|---|---|---|---|
| Spirometry | | | | |
| FVC (L) | 3.69 | 3.27 | 89 | 3.36 |
| $FEV_1$ (L) | 3.10 | 2.93 | 94 | 2.93 |
| $FEV_1/FVC$ (%) | 84 | 89 | | |
| $FEF_{25-75}$ (L/s) | 3.1 | 4.0 | 131 | |
| MVV (L/min) | 113 | 121 | 106 | |
| Volumes | | | | |
| TLC (L) | 5.04 | 4.62 | 92 | |
| RV/TLC (%) | 27 | 21 | 78 | |
| $D_{LCO}$ (mL/min/mm Hg) | 24 | 24 | 100 | |




- severe ventilatory limitation due to obstruction
- markedly reduced FEV1/FVC
- ↓ FEV1 & FEF values are consistent with obstruction
- ↑ in TLC and RV/TLC are consistent with obstruction
- what does the normal DLCO tell you?
- does this person respond to b/dilators?
- the last two points are typical of what type of patient?

67 y M Wt 189 lb (86 kg) Ht 71 in. (180 cm)

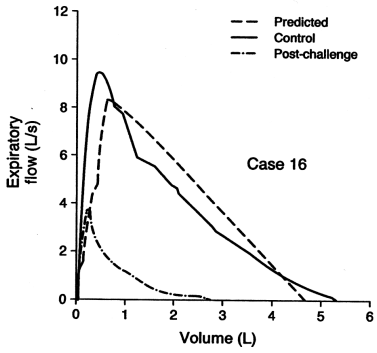
| | *Normal* | *Observed* | *% predicted* | *Post-dilator* |
|---|---|---|---|---|
| Spirometry | | | | |
| FVC (L) | 4.79 | 2.06* | 43 | 2.67 |
| $FEV_1$ (L) | 3.67 | 0.56* | 15 | 0.75 |
| $FEV_1/FVC$ (%) | 77 | 27* | | |
| $FEF_{25-75}$ (L/s) | 31 | 0.2* | 6 | |
| MVV (L/min) | 136 | 29* | 21 | |
| Volumes | | | | |
| TLC (L) | 7.02 | 8.64* | 123 | |
| RV/TLC (%) | 32 | 69* | 216 | |
| $D_{LCO}$ (mL/min/mm Hg) | 27 | 21 | 79 | |




- data looks normal
- the loss of area suggests some sort of mild limitation
- contour of curve looks obstructive
- measurement of TLC would help determine if there is any restriction
- patients weight may play a role if there is some evidence for restrictive disease

64 y F Wt 377 lb (171 kg) Ht 65 in. (165 cm)

| | *Normal* | *Observed* | *% predicted* | *Post-dilator* |
|---|---|---|---|---|
| Spirometry | | | | |
| FVC (L) | 3.13 | 2.89 | 92 | 2.81 |
| $FEV_1$ (L) | 2.48 | 2.15 | 87 | 2.1 |
| $FEV_1/FVC$ (%) | 80 | 74 | | |
| $FEF_{25-75}$ (L/s) | 2.2 | 1.6 | 73 | |
| MVV (L/min) | 94 | 90 | 96 | |
| $D_{LCO}$ (mL/min/mm Hg) | 21 | 25 | 119 | |




- this young man has had asthma & hay fever since age 6.
- his data is presented here to show the extreme response to methacholine [5mg/mL] challenge.
- his control data suggest obstructive ventilatory limitation based on FEV1/FVC ratio

17 y M Wt 170 lb (77 kg) Ht 69 in. (175 cm)

| | *Normal* | *Observed* | *% predicted* | *Post-challenge* | *% change* |
|---|---|---|---|---|---|
| Spirometry | | | | | |
| FVC (L) | 4.67 | 5.37 | 115 | 2.72 | −49 |
| $FEV_1$ (L) | 4.02 | 3.88 | 96 | 1.45 | −63 |
| $FEV_1/FVC$ (%) | 86 | 72* | | 53 | |
| $FEF_{25-75}$ (L/s) | 4.5 | 2.8 | 63 | 0.6 | |
| MVV (L/min) | 161 | 144 | 89 | | |
| Volumes | | | | | |
| TLC (L) | 6.06 | 6.68 | 110 | | |
| RV/TLC (%) | 19 | 20 | 105 | | |
| $D_{LCO}$ (mL/min/mm Hg) | 32 | 30 | 95 | | |

# The Flow Volume Loop & Airway Obstruction

**Fixed Obstruction**
- **foreign bodies / tumors**
- **scarring/stiffening of upper airways**

**Variable Extra-thoracic**
- **tumors/ fat deposits**
- **weakened pharyngeal muscles**
- **tracheomalacia**
- **paralyzed vocal chords**
- **enlarged lymph nodes**
- **inflammation**

**Variable Intra-thoracic**
- **tumors**
- **airway chondromalacia**
- **mediastinal adenopathy**