Interpretation of Airway Function Tests

Jeff Pretto

Austin Hospital, Heidelberg,
Victoria, Australia

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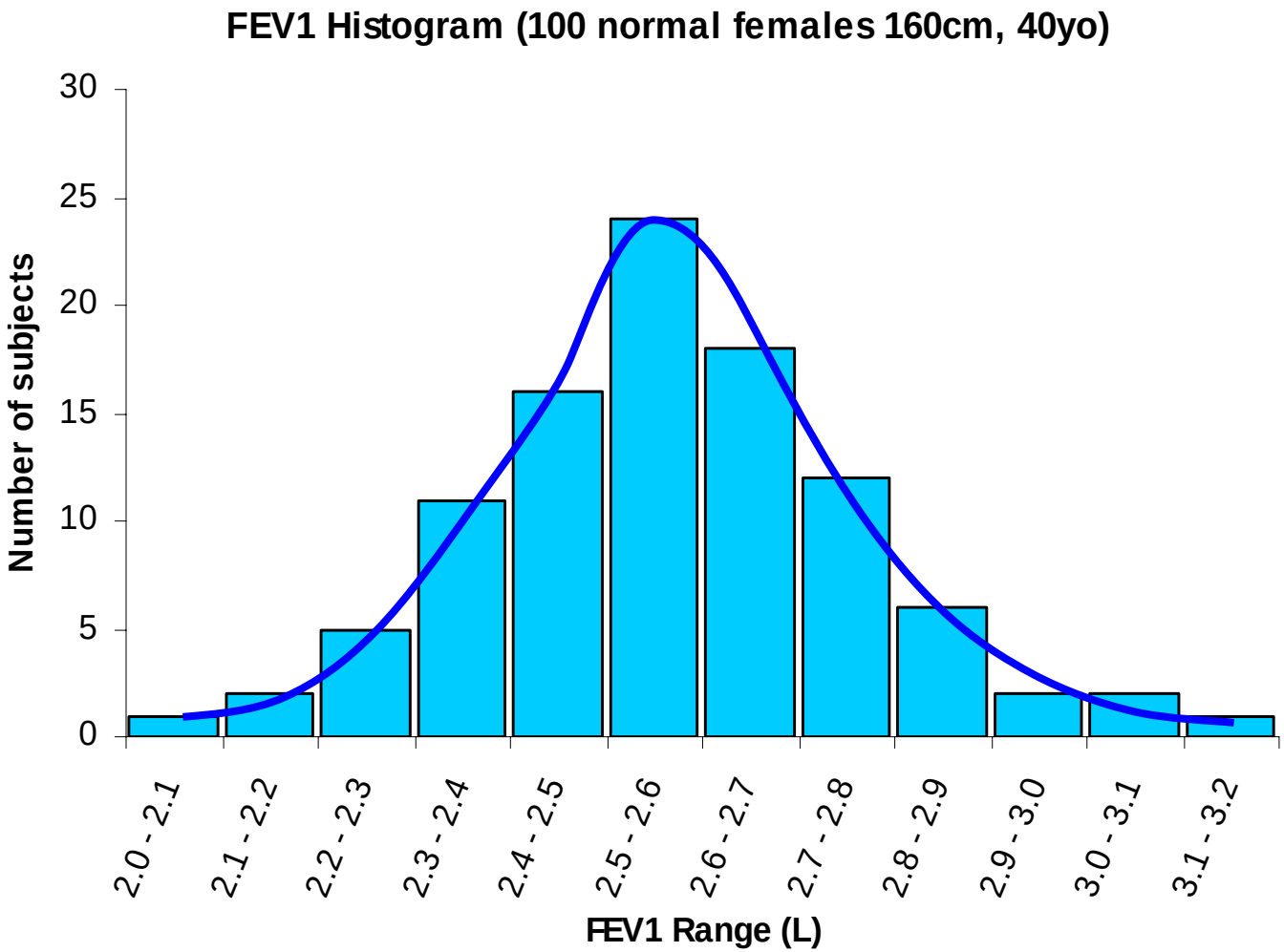
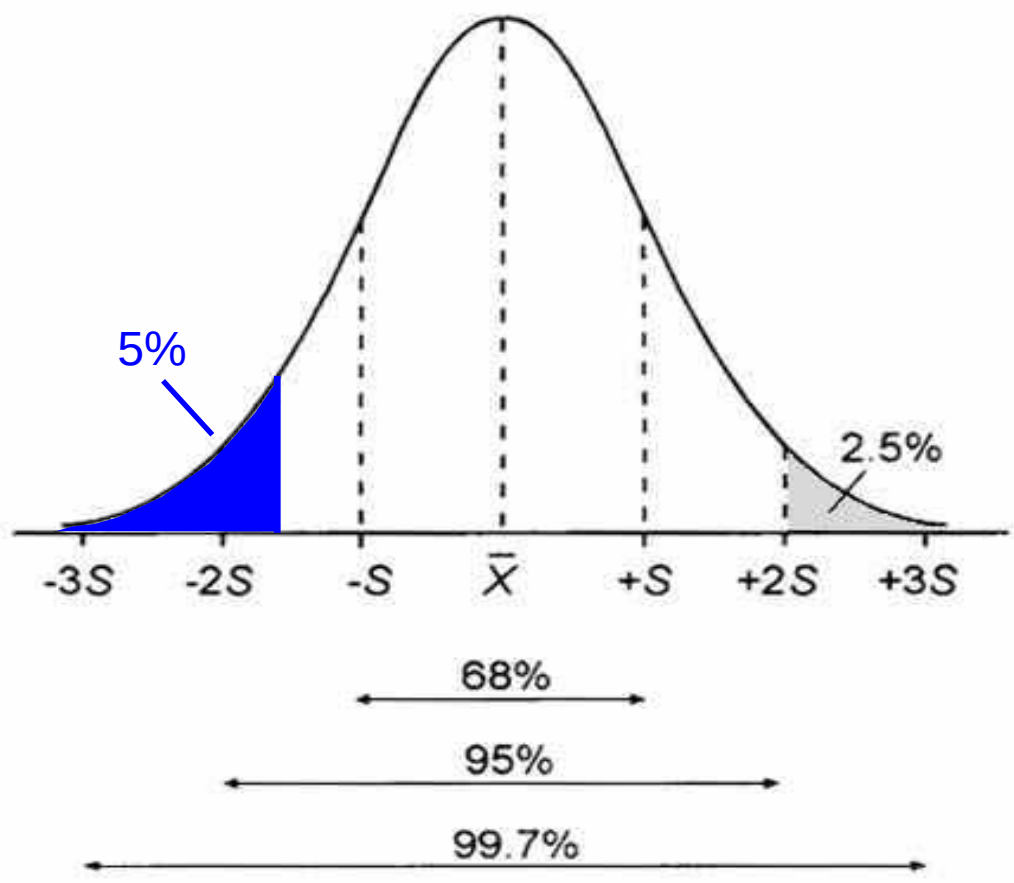
Australian & New Zealand Society of Respiratory Science

Predicted values



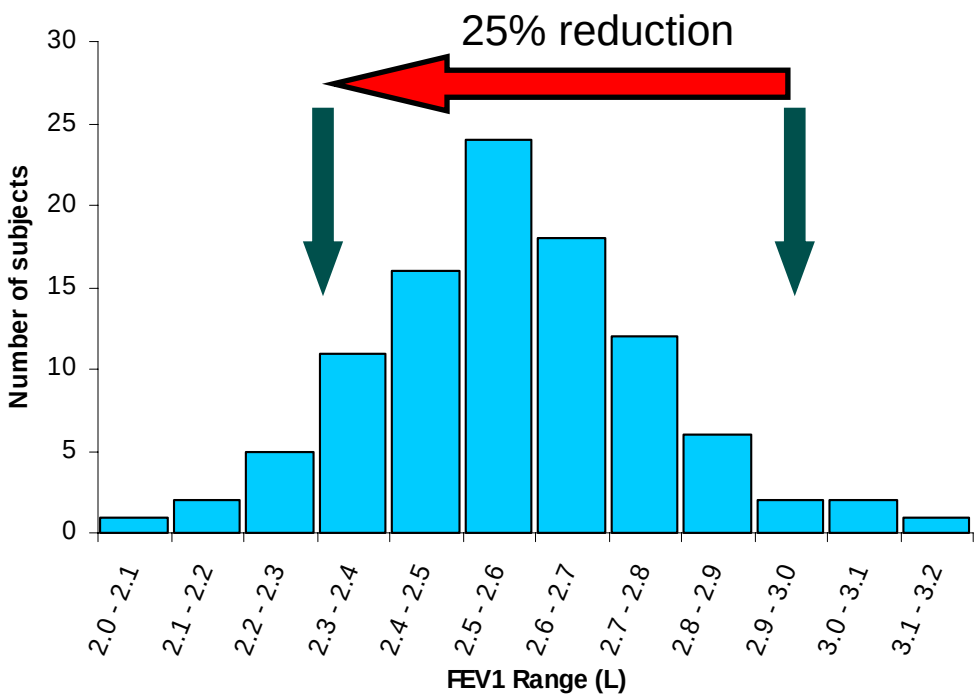
The normal distribution



- for FEV1, disease tends to cause a reduction (plus it is probably good rather than bad to have a high FEV1
- we therefore want to find a lower limit to the normal range
- where we select the LLN is defined by the margin of error we are happy to accept
- this is usually 5%
- this point is at $\overline{X}$ - 1.64 S

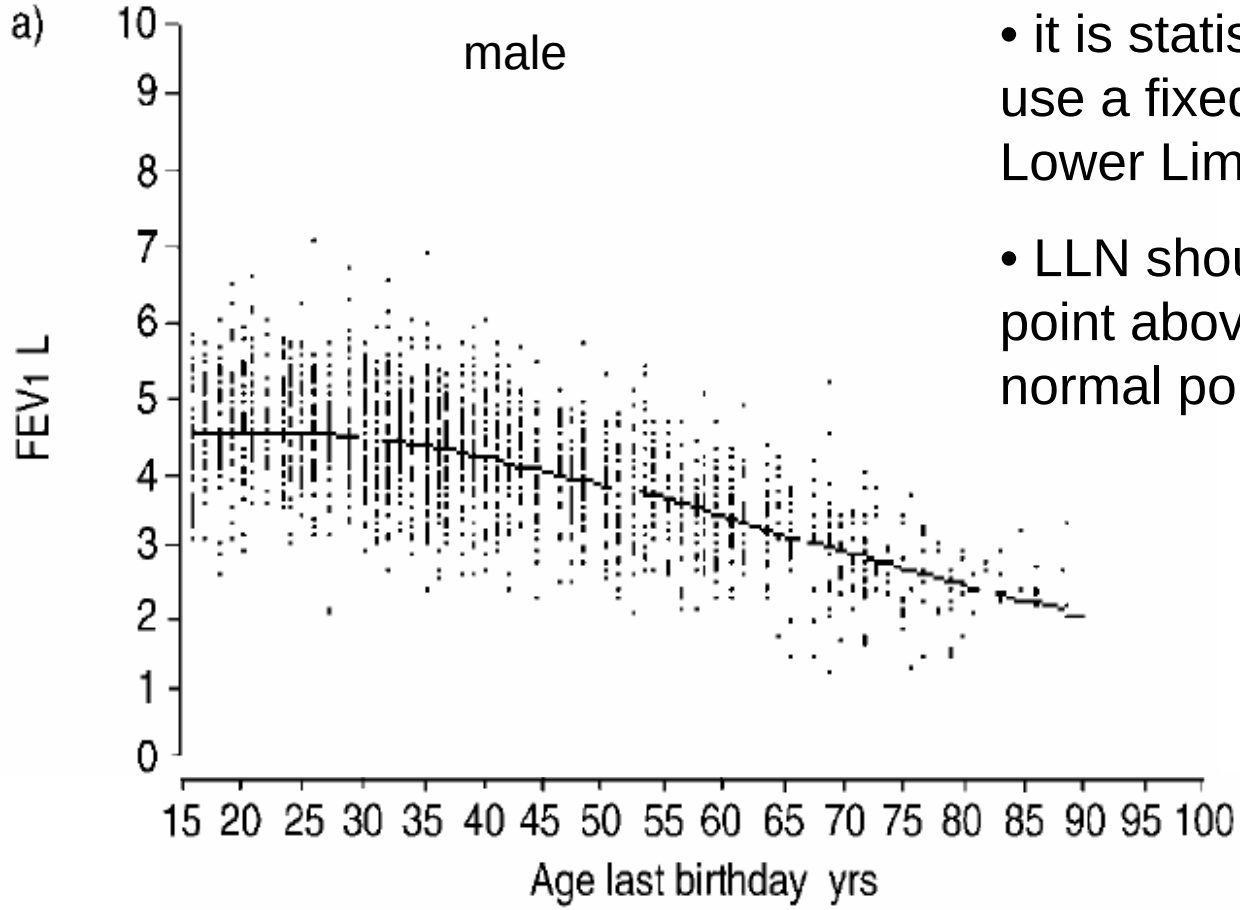
Predicted values

• cannot say that a result is ‘normal’, only that it is ‘within normal limits’ since we do not usually know an individual’s starting point



• it is more valuable to compare results with previous tests than with predicted values

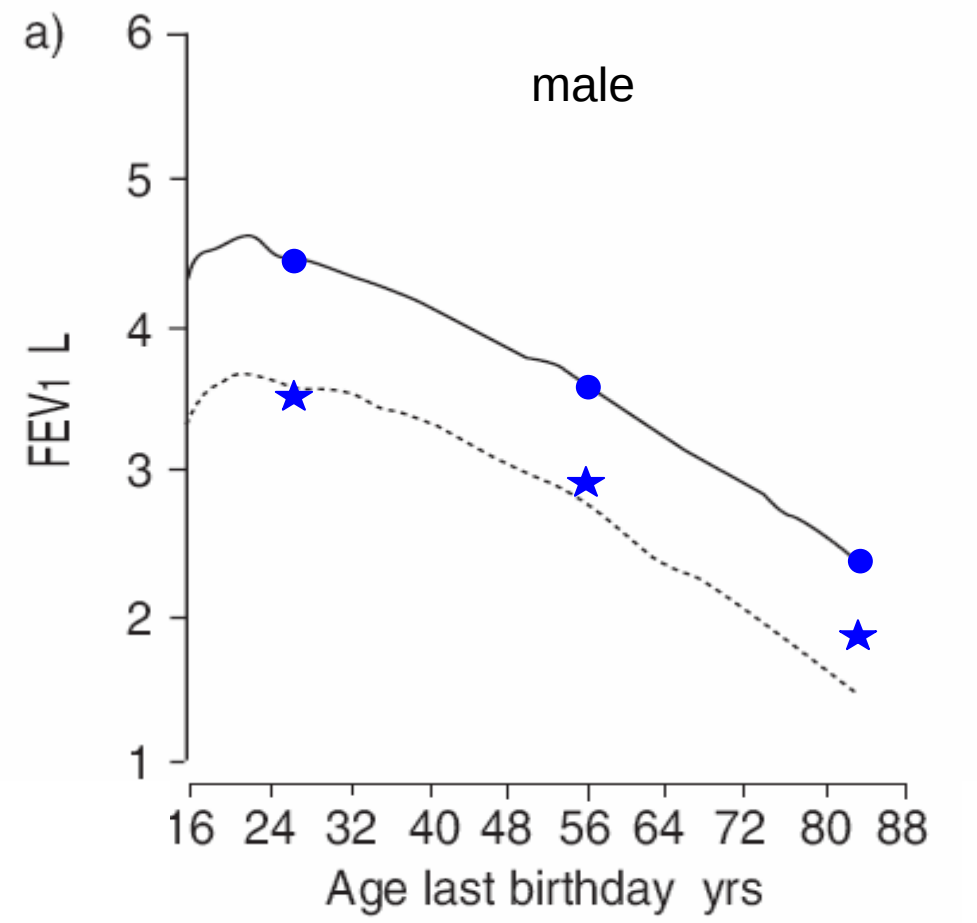
Predicted normal values



- it is statistically erroneous to use a fixed % to define the Lower Limit of Normal (LLN)
- LLN should be defined as the point above which 95% of the normal population lay

*E. Falaschetti et al. *Prediction equations for normal and low lung function from the Health Survey for England.* Eur. Respir. J., 2004.

Ranges of normality – FEV1



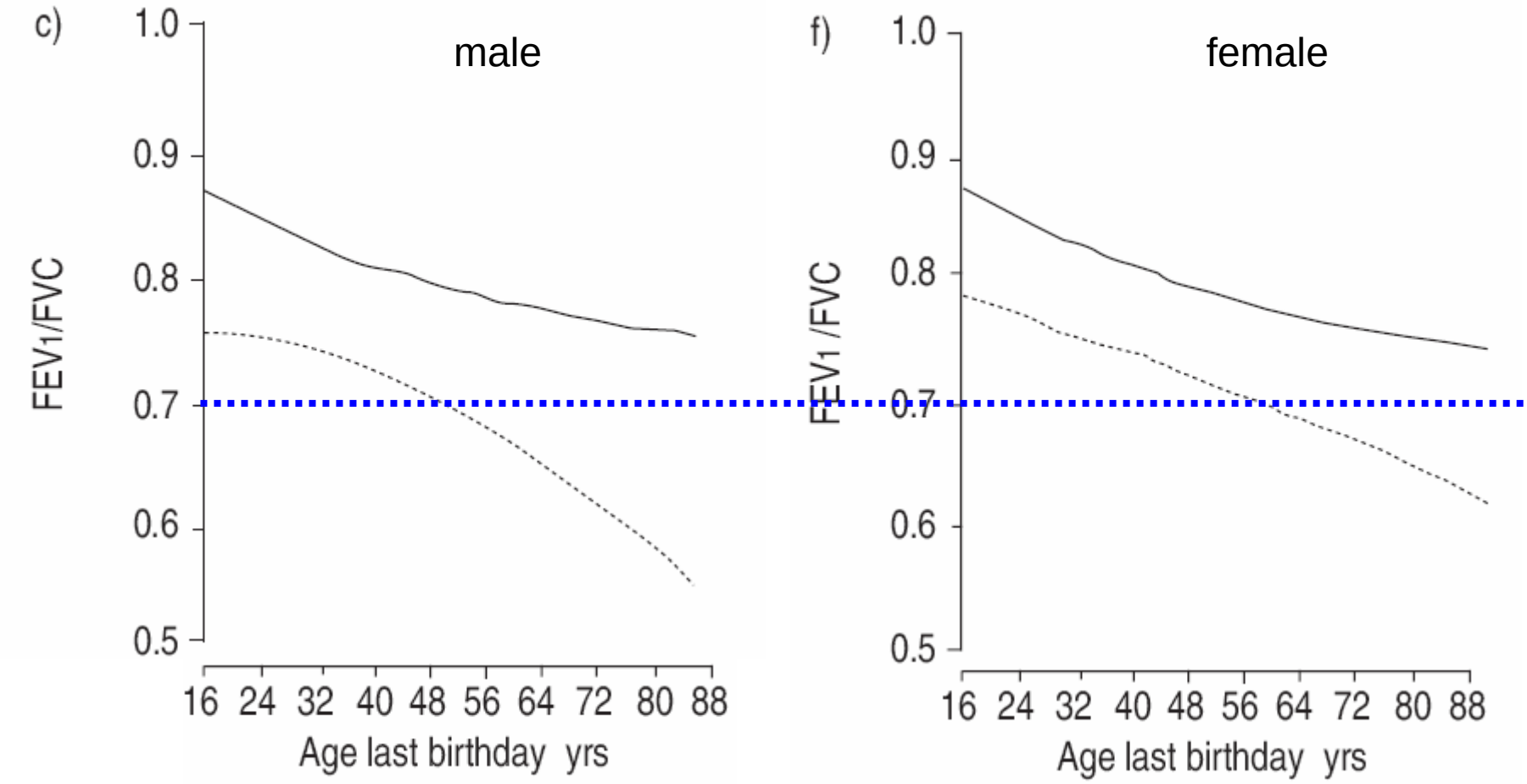
- 20% below the mean predicted value as LLN causes overestimation of disease in elderly

● Mean predicted value

★ Mean - 20%

From Falaschetti et al. Eur. Respir. J., 2004.

Ranges of normality - FER



From Falaschetti et al. Eur. Respir. J., 2004.

Severity scaling

- Reduced FEV1/FVC (FER) defines airflow obstruction
  - Not FER < 70%, but FER < LLN
- Severity of obstruction previously characterised using FER
- Latest ATS/ERS recommendations*:
  - Severity characterised by FEV1 as % of predicted
  - This applies to restrictive disease as well

***R. Pellegrino et al. Interpretative strategies for lung function tests. Eur. Respir. J., 2005.**

Severity scaling* - ATS/ERS consensus

FER < LLN	Airflow obstruction
FEV1% $\geq$ 70	Mild
60 $\leq$ FEV1% < 70	Moderate
50 $\leq$ FEV1% < 60	Moderately severe
35 $\leq$ FEV1% < 50	Severe
FEV1% < 35	Very severe

***R. Pellegrino et al. Interpretative strategies for lung function tests. Eur. Respir. J., 2005.**

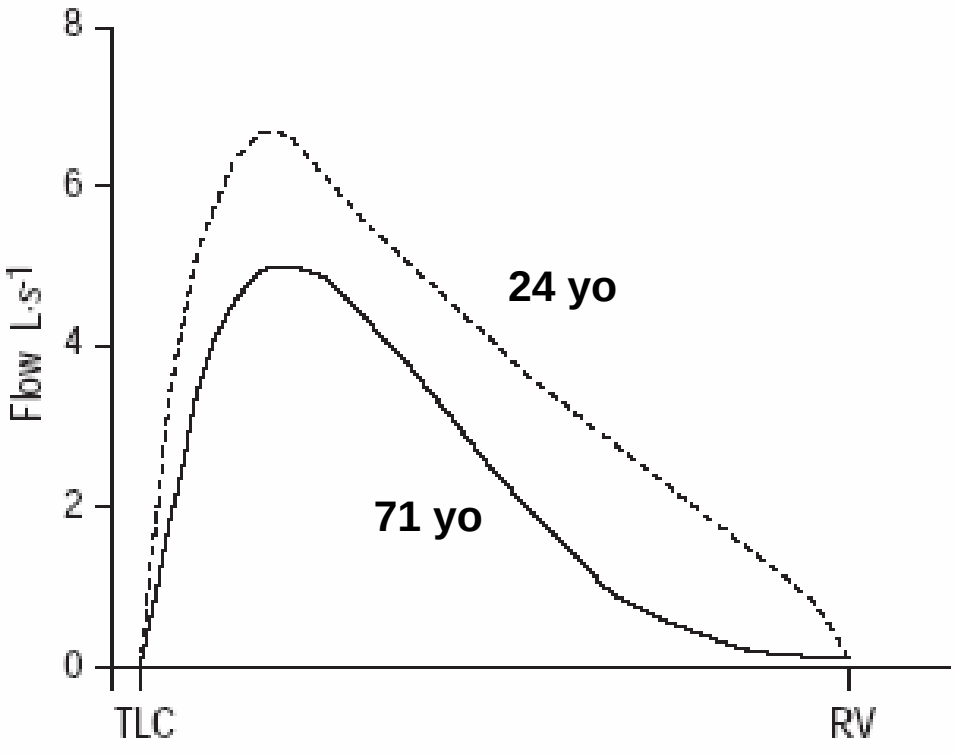
Bronchodilator response

- Measured to determine if bronchospasm is contributing to airflow obstruction
- Significant response is improvement:
  - of > 200ml, and
  - of > 12% of baseline value
  - in FEV1 **or** FVC
- PF, MMEF, FER are not useful in defining BD response
- Absence of response does not infer lack of
  - bronchial responsiveness
  - potential therapeutic benefit

***R. Pellegrino et al. Interpretative strategies for lung function tests. Eur. Respir. J., 2005.**

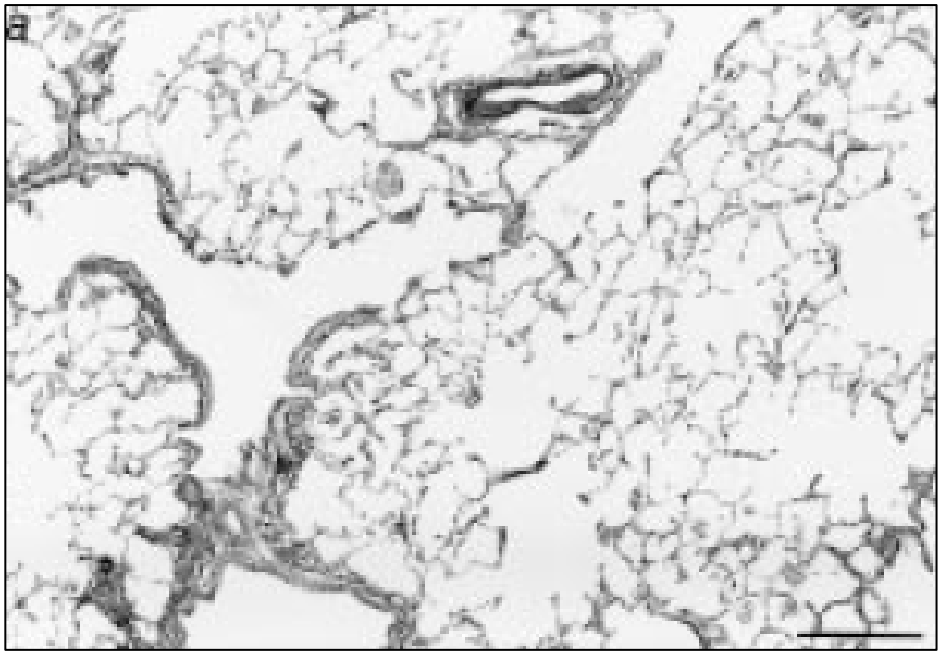
Flow Volume shape

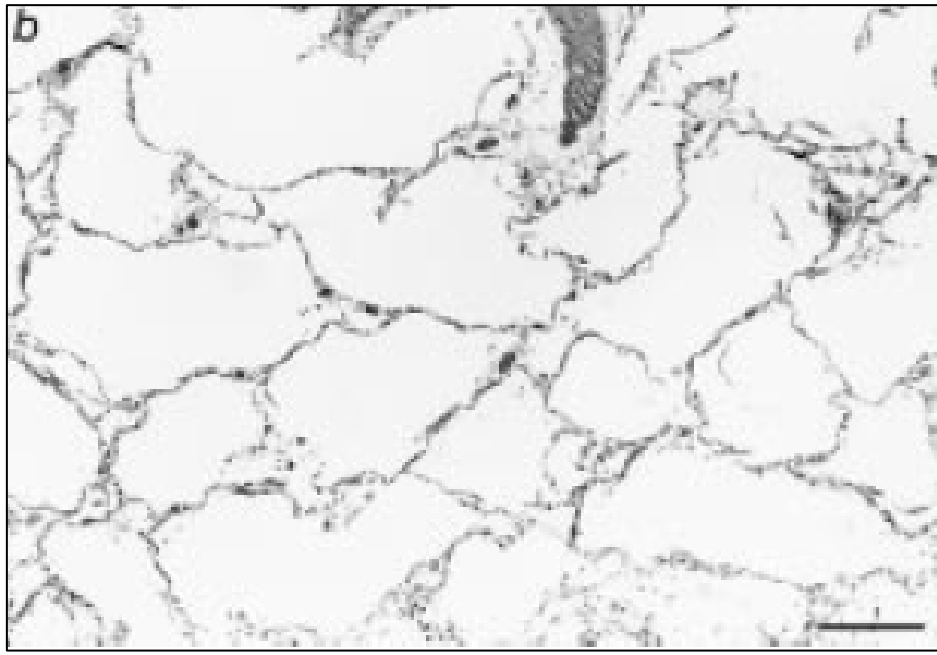
- Normal shape is a triangle on a semi circle
- AO reduces flowrates, so get concavity in expiratory curve
- Convexity expected in younger patients, some concavity in older



From RW Fowler et al. Thorax, 1987

Lung parenchyma and aging





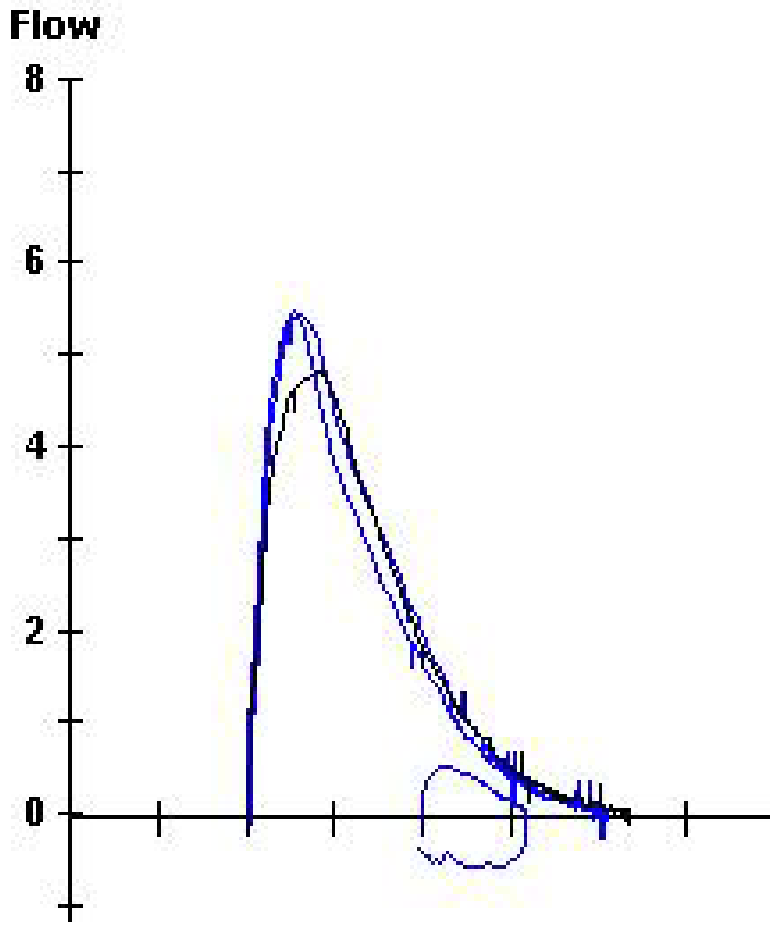
29 yo non-smoker

100 yo non-smoker

Flow Volume shape

- 66 yo male, never smoker with exertional dyspnoea
- 155cm, 62kg, BMI=25.8

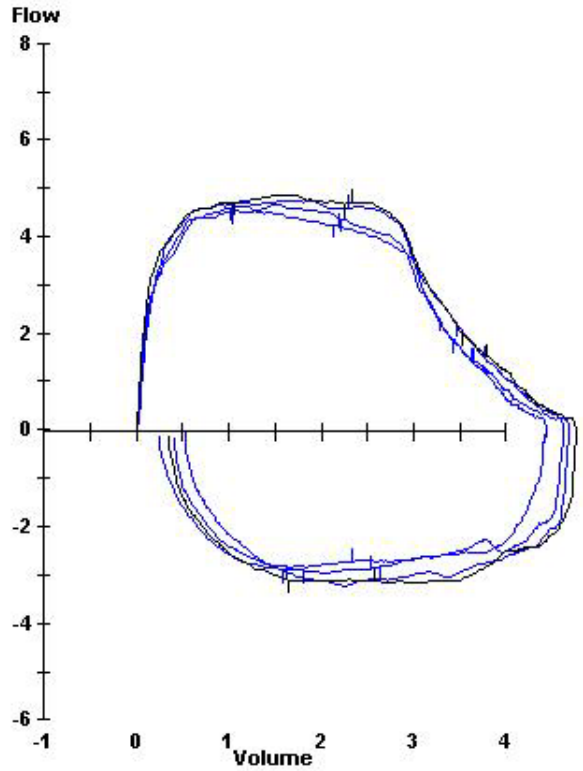
	Normal Range	*Result*	*(%mean pred.)*
FEV1	> 1.18	**1.59**	**77%**
FVC	> 1.71	**2.21**	**82%**
FEF_{25-75}	> 1.2	**1.4**	**46%**
FER	> 70	**72%**	



Flow Volume shape

- 41 yo female with exertional dyspnoea and wheeze
- 164cm, 61kg, BMI=22.5

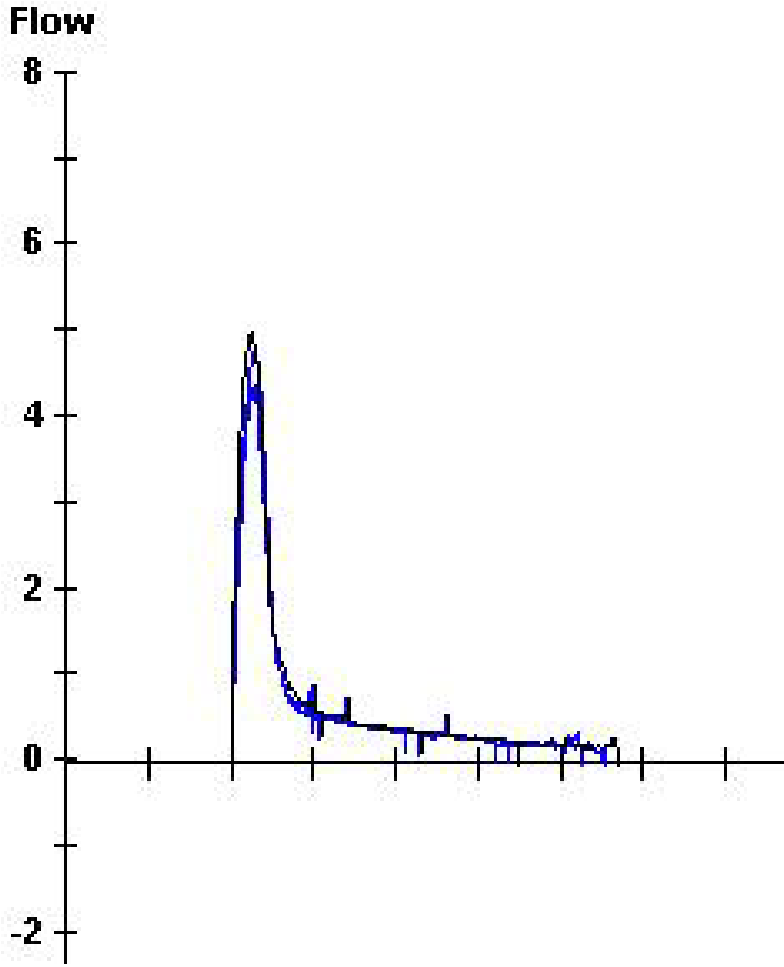
	Normal Range	*Result*	*(%mean pred.)*
FEV1	> 2.06	**3.43**	**124%**
FVC	> 2.54	**4.50**	**133%**
FEF_{25-75}	> 1.2	**2.9**	**80%**
FER	> 72	**74%**	



Gas Trapping - Slow v. forced vital capacity

- In normal subjects, SVC = FVC
- In airflow obstruction, SVC is commonly > FVC

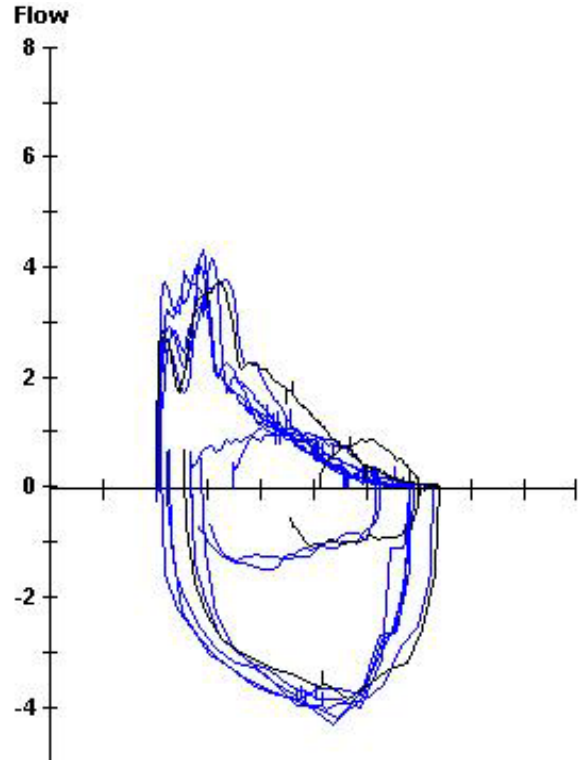
	Normal Range	*Result*	*(%mean pred.)*
FEV1	> 2.29	**0.74**	**23%**
FVC	> 3.03	**2.36**	**59%**
VC	> 3.03	**2.89**	**72%**
FER	> 71	**26%**	



Site of obstruction – Raw, Sgaw

- An increased Raw indicates obstruction of the larger airways
- 78yo with COPD, asbestos exposure, thyroid goitre

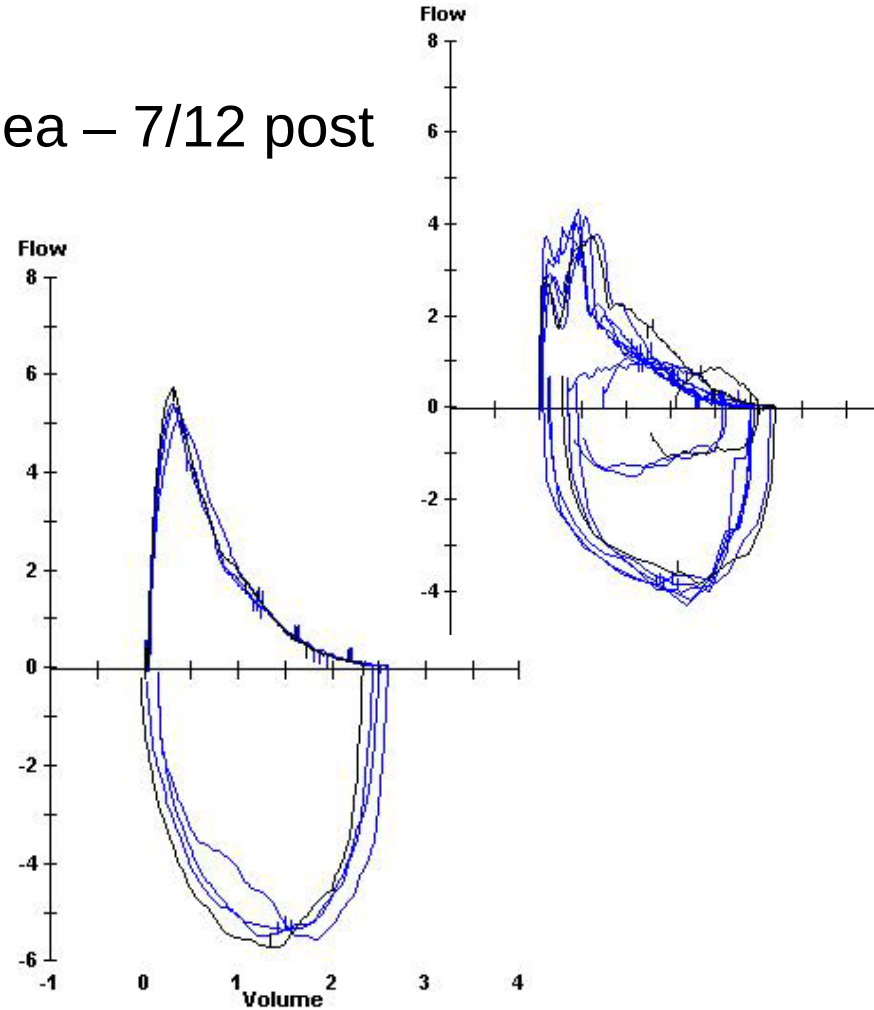
	Normal Range	*Result*	*(%mean pred.)*
FEV1	> 1.61	**1.71**	**68%**
FVC	> 2.30	**2.65**	**80%**
FER	>67	**65**	
Raw	0.5 – 2.0	**3.8**	



Site of obstruction – Raw, Sgaw

- Thyroid goitre compressing trachea – 7/12 post surgery

	Normal Range	*21/1/04*	*16/11/04*
FEV1	> 1.61	**1.71**	**1.65**
FVC	> 2.30	**2.65**	**2.60**
FER	>67	**65**	**63**
Raw	0.5 – 2.0	**3.8**	**2.9**



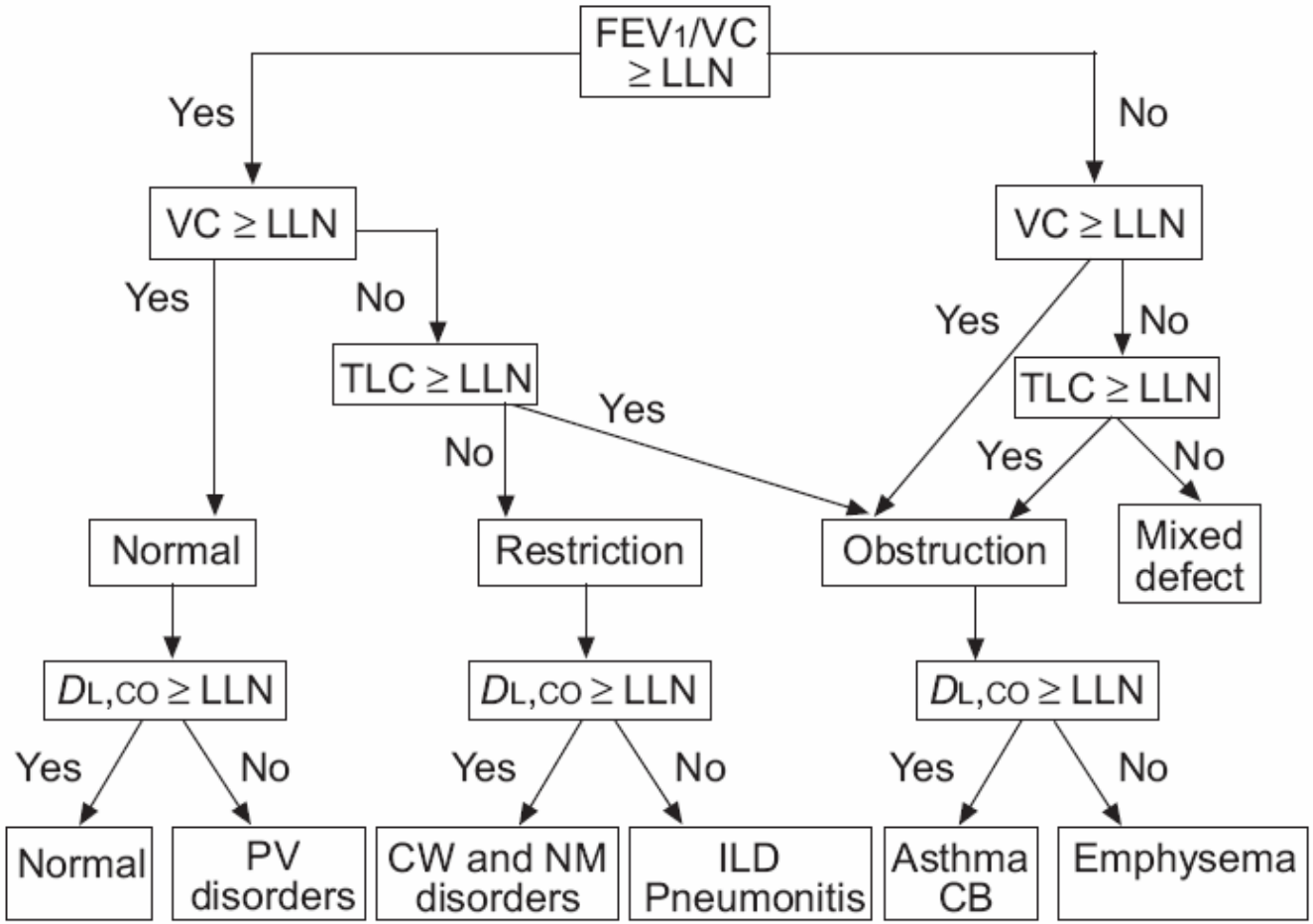
Site of obstruction – FOT and other goodies

- Forced oscillation technique (FOT):
  - Assesses total respiratory resistance (includes resistance offered by airways, lung tissue and chest wall
  - Non-invasive assessment requiring little cooperation
  - Useful in early detection of airflow obstruction and in assessment of BHR
- Nasal resistance
  - May be important in OSA
  - Can characterise fixed versus functional using oxymetazaline (vasoconstrictor)

Interpretative Strategies – standardized approaches

- Automated algorithms appeared in early 1970s
- Coincided with appearance of computers rather than as effort for standardization
- Little consensus from learned societies until 2005 ATS/ERS statement

Interpretative flowchart – ERS/ATS consensus



R. Pellegrino et al. Interpretative strategies for lung function tests. Eur. Respir. J., 2005.

Interpretative Strategies – General approach

- Look at demographics for unusual features
  - Height
  - Age
  - BMI
- Look at technical comment, clinical notes
- Assess flow volume shape for specific patterns
- Look at values and compare with normal ranges and previous results
- Make general descriptive comment
- Add clinical interpretation – must answer question asked.

Practice Exam Question 52

A patient is noted to have a reduced FEF25-75% and FEV1. The FVC and Raw are normal. Which of the following best explains these findings?

A the site of dysfunction is in the peripheral airways

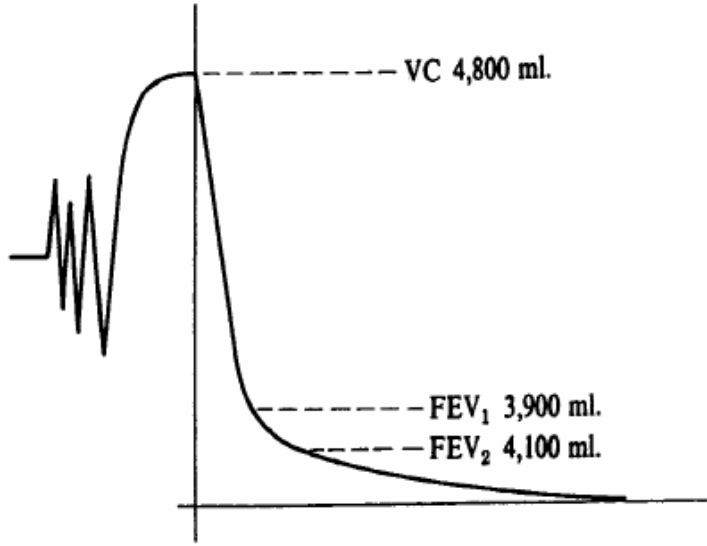
B a fixed upper airway obstruction is present

C there is decreased chest wall compliance

D there was submaximal effort during the Raw measurement

Practice Exam Question 57

The spirogram was obtained from a 35 yo male who smokes 2 packs/day and frequently experiences morning cough. Which of the following can be concluded:



A The FEV1/FVC ratio is within the normal range

B the curve represents obstructive lung disease

C a combined obstructive and restrictive defect is present

D an advanced stage of restrictive defect is present

Practice Exam Question 58

A 35 year old, 183 cm male complaining of shortness of breath with exercise has the following spirometry data:

VC = 4.6 L FEV1 = 2.1 L

FVC = 3.6 L $FEF_{25-75\%}$ = 2.5 L/sec

Which of the following tests would be indicated as the next step in evaluation of the patient's problem?

A measure RV/TLC ratio

B exercise induced asthma study

C bronchodilator response

D single breath DLCO

Practice Exam Question 59

Correct conclusions about a 180cm, 40 years old male subject who has an FEV1/FVC ratio of 65% include which of the following?

1 his FEV1/FVC ratio is below normal

2 he has obstructive lung disease

3 he has restrictive lung disease

4 he has diffusion impairment

A 1 only

B 3 only

C 1, 2 and 4

D 1 and 2

Practice Exam Question 60

A patient has an FEV1 of 1.91 litres (52% of the predicted value). Which of the following might result in this low value:

1 small airways obstruction
2 hesitation at the start of test
3 restriction due to fibrosis
4 an FVC greater than predicted

A 1, 2, 3 and 4

B 1, 3 and 4

C 1, 2 and 3

D 2 and 4