Spirometry

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AIMS

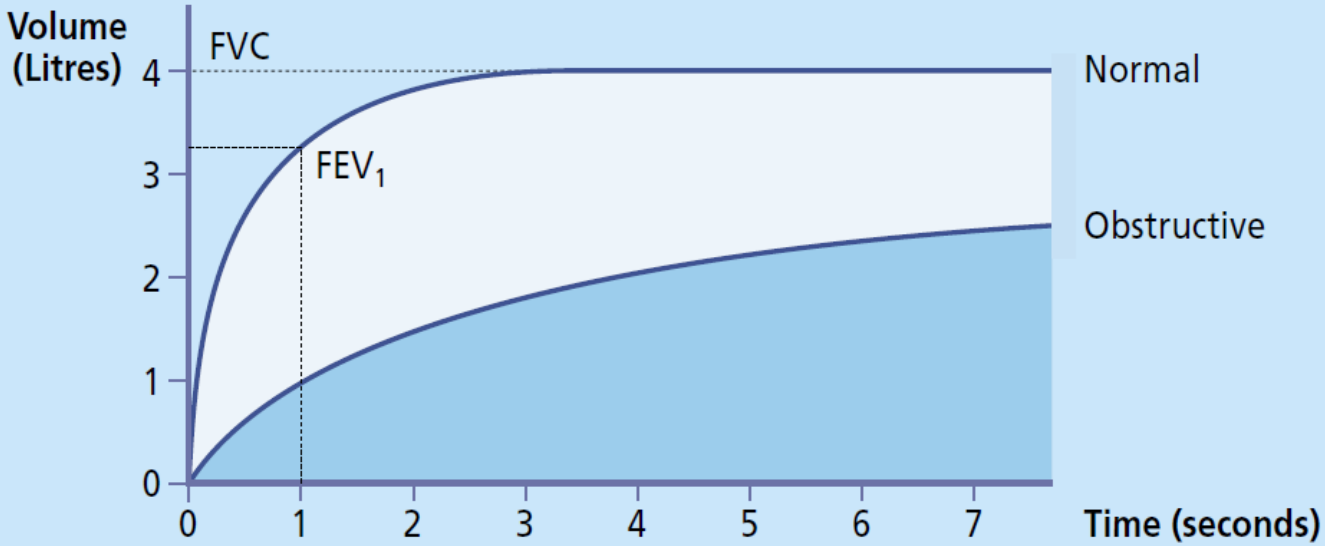
- Understand that spirometry is a key investigation to aid diagnosis of asthma and COPD in general practice
- Understand when to request spirometry
- To be able to assess the quality of the test (acceptable, invalid, ?needs repeat)
- Interpret FEV1, FVC and FEV1/FVC and flow-time graphs and volume-flow loops to aid diagnosis
- Use patient's experience to engage in a conversation of behavioural change

Uses of spirometry

- For the Dr- aids in diagnosis-
- ?Obstructive lung disease
  - ?Is it asthma
  - ?Is it COPD
- ?Restrictive lung disease
  - Refer to respiratory physician for Pulmonary Function Tests
- For the patient-
  - *Experiencing and recognising* the problem
  - Supports behavioural change eg. Correct inhaler use, smoking cessation

Spirometry

Forced Expiratory Volume in 1 second (FEV_1) and Forced Vital Capacity (FVC)



- **Spirometry gives three important measures:**
  - **FEV_1:** the volume of air that the patient is able to exhale in the first second of forced expiration
  - **FVC:** the total volume of air that the patient can forcibly exhale in one breath
  - **FEV_1/FVC:** the ratio of FEV_1 to FVC expressed as a percentage
- **Spirometry can also be used to measure:**
  - **VC:** slow vital capacity
  - **FEV_1/VC:** the ratio of FEV_1 to the slow vital capacity
- Values of FEV_1 and FVC are expressed as a percentage of the predicted normal for a person of the same sex, age and height
- **COPD can be diagnosed only if FEV_1 <80% predicted and FEV_1/FVC <0.7 (70%)**
  The severity of the airflow obstruction in COPD is indicated by the extent of FEV_1 reduction
- Asthma may show the same abnormalities on spirometry as COPD – if there is diagnostic doubt spirometry following reversibility testing may be used to identify asthma

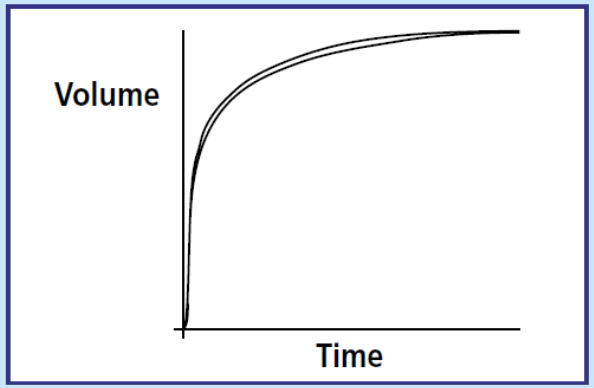
N.B. Predicted values may be lower in non-caucasians.

Limitations of spirometry

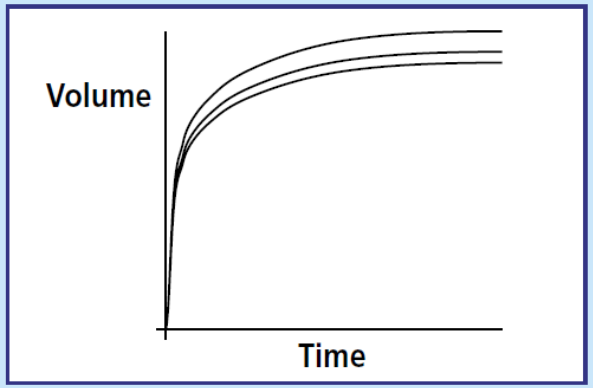
- Results dependant on patient technique
  - Ensure at least 3 consistent, acceptable readings before assessing spirometry values
  - Difficult to be performed on children <8 years old. Diagnosis of asthma largely depending on clinical history eg. Viral induced wheeze vs asthma

Inconsistent and consistent volume-time curves

Three consistent volume-time curves are required of which the best two curves are within 100ml or 5% of each other.



Consistent: Three acceptable and consistent traces.



Inconsistent: Although each trace is technically acceptable, they are inconsistent.

Limitations of spirometry

- Need to withhold treatment to do spirometry
  - Don't perform during acute exacerbation
  - Withhold SABA for 6-8 hours
  - Withhold LABA – 12 – 24 hours

Interpretting results

- Minimum of 3 *consistent* and *acceptable* readings before assessing spirometry
- Use *best of 3* consistent readings for FEV1 and FVC
- Compare to predicted normal values (dependant on age, sex, height, ethnicitiy, smoking status)

- ***Abnormal values***
  - **FEV1 <80% of predicted**
  - **FVC < 80% of predicted**
  - **FEV1:FVC <0.7**

Obstructive vs restrictive lung diseases

	Obstructive	Restrictive
FEV1	< 80%	<80%
FVC	reduced	**<80%**
FEV1 / FVC	**<0.7**	>= 0.7

FEV1/FVC < 0.7

→ obstructive

- **Now Is it asthma or COPD?**
- **Is FEV1 reversible?**
  - Ie. Does FEV1 improve with bronchodilator treatment?

    if **FEV1 improves by at least 200mL AND 12%, or 12% (children) : asthma**

    If **FEV1 shows only limited (or no) improvement: COPD** *"not fully reversible"*

FEV1/FVC normal (> 0.7),

but FVC <0.8

→ Restrictive lung diseases

- Refer to respiratory physician for Pulmonary Function Testing (PFT)
- Eg
  - Fibrosing alveolitis
  - Asbestosis
  - Sarcoidosis

Shapes can give clues

- Volume vs time curves

Identifying abnormalities

Spirometry indicates the presence of an abnormality if any of the following are recorded:

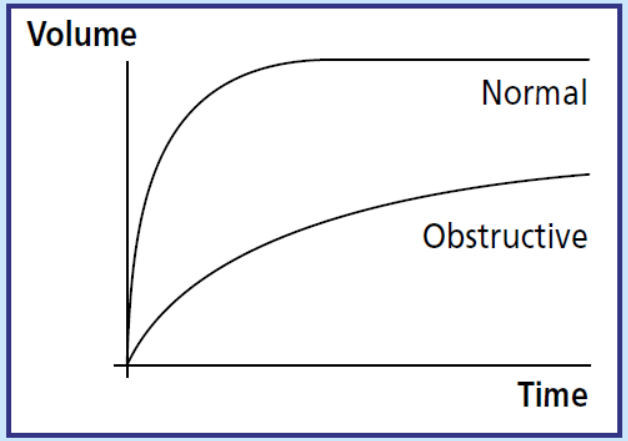
- FEV_1 <80% predicted normal
- FVC <80% predicted normal
- FEV_1/FVC ratio <0.7

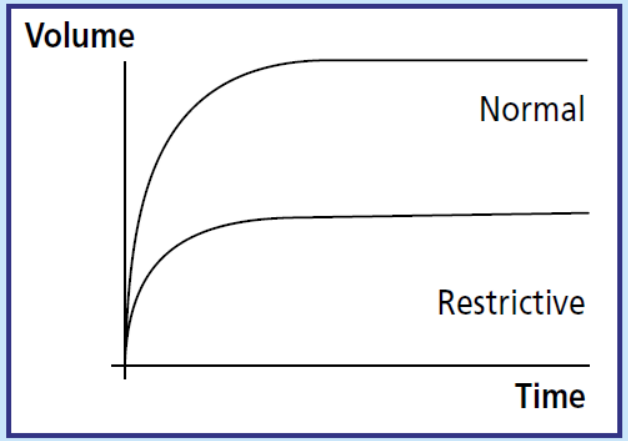
Obstructive disorder:

- FEV_1 reduced (<80% predicted normal)
- FVC is usually reduced but to a lesser extent than FEV_1
- FEV_1/FVC ratio reduced (<0.7)

Restrictive disorder:

- FEV_1 reduced (<80% predicted normal)
- FVC reduced (<80% predicted normal)
- FEV_1/FVC ratio normal (>0.7)





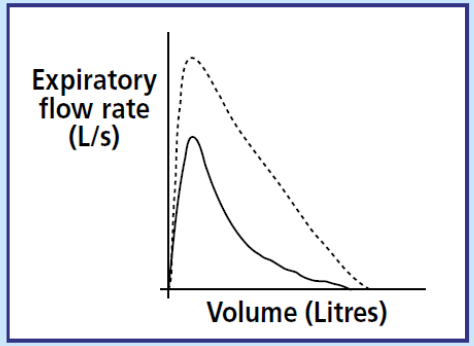
Shapes can give clues

Flow rate vs volume loops

Identifying abnormalities with flow-volume curves

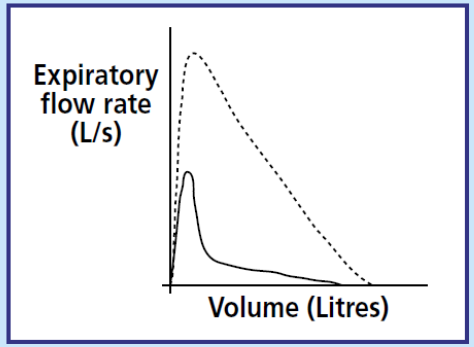
Obstructive disorder:

In this example of a patient with obstructive airways disease, the peak expiratory flow (PEF) is reduced and the decline in airflow to complete exhalation follows a distinctive dipping (or concave) curve.



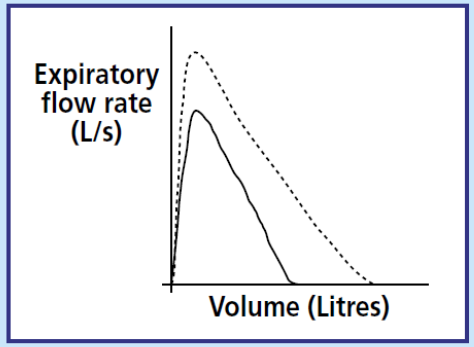
Severe obstructive disorder:

In a severe airflow obstruction, particularly with emphysema, the characteristic 'steeple pattern' is seen in the expiratory flow trace.



Restrictive disorder:

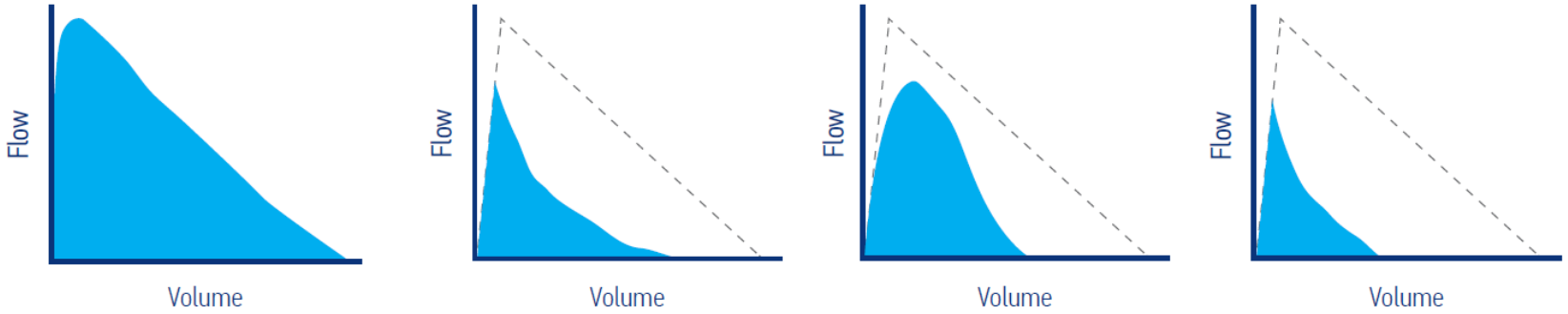
The pattern observed in the expiratory trace of a patient with restrictive defect is normal in shape but there is an absolute reduction in volume.



Mixed lung diseases

- May have features of both obstructive and restrictive lung diseases
  - Eg. Smoker with asbestosis
- Can you guess the shape of the flow-volume loop?

Take home messages

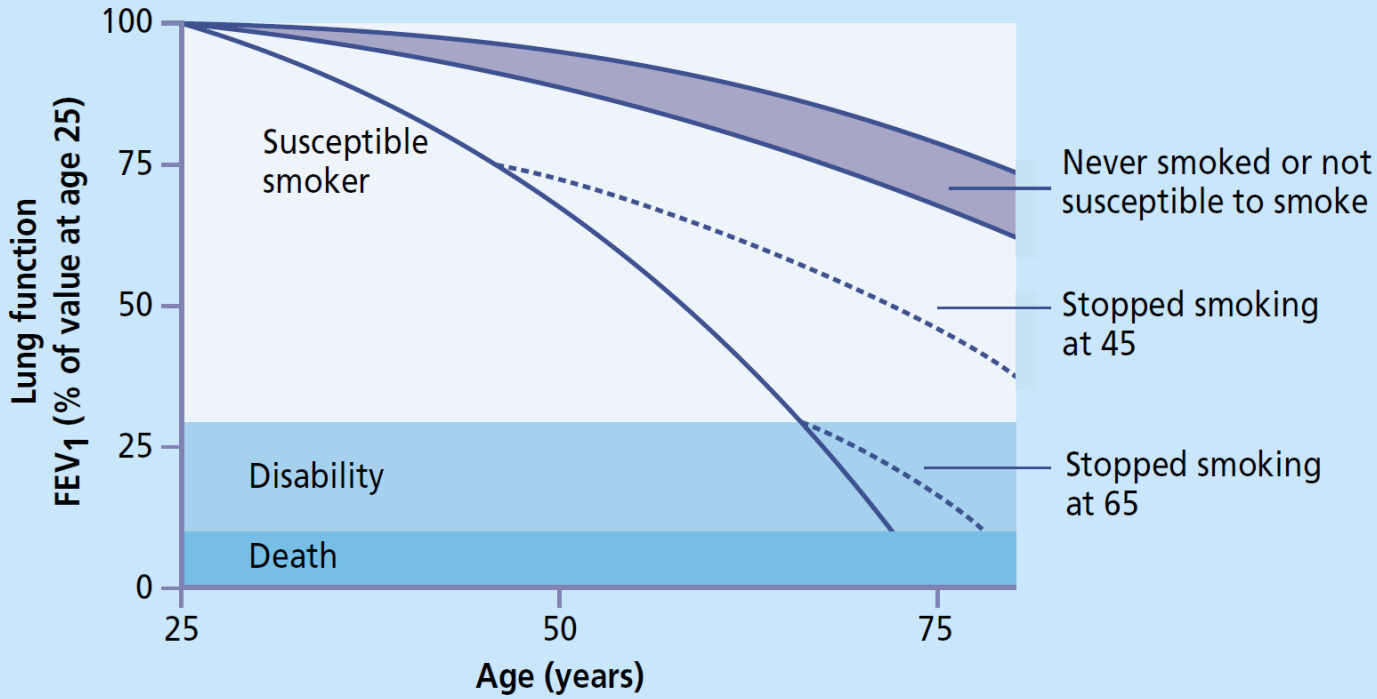


Types of ventilatory defects

	Obstruction	Restriction	Mixed defect
Problem	Expiratory airflow limitation: unable to blow out quickly *e.g. asthma, COPD, overlap of asthma and COPD*	Limitation to inspiration: small lungs *e.g. obesity, pulmonary fibrosis, pleural/chest wall disease, weak inspiratory muscles*	Small lungs and unable to blow out quickly
Spirometry findings	Reduced FEV_1/FVC ratio	Low FVC but normal or high FEV_1/FVC ratio	Reduced FEV_1/FVC ratio plus low FVC

Smoking cessation reduces likelihood of disability or death

Smoking accelerates the normal age-related decline in lung function



In susceptible individuals, smoking accelerates the age-related decline in lung function, but this returns to the normal rate if the patient stops smoking (Adapted from Fletcher C. & Peto R. *BMJ* 1977; **1:** 1645–1648).

Spirometry 101

- 1. Is FEV1 reduced less than 80% of predicted? → Abnormal
- 2. Is FVC reduced less than 80% predicted? → Abnormal
  - Check that FEV1:FVC is normal (>0.7) → Restrictive or normal
- 3. If FVC is not reduced less than 80% of predicted
  - check FEV1:FVC < 0.7 → obstructive
    - Is it reversible → asthma
    - Not reversible → COPD
- 4. Check whether consistent with clinical history

  (COPD and asthma can co-exist; restrictive and obstructive diseases can co-exist)
- 5. Check shapes of volume-time and flow-volume loops
  - Are there elements of both? Eg. Mixed lung disease
- 6. Patient centred explanation-
  - restrictive is "a problem with breathing in";
  - obstructive is "a problem with "breathing out"
  - "these inhalers are to help you breathe"

References:

- Asthma Foundation- Spirometry Quick Reference Guide

https://www.nationalasthma.org.au/living-with-asthma/resources/health-professionals/information-paper/spirometry-quick-reference-guide

- British Thoracic Society – Spirometry in practice

https://www.brit-thoracic.org.uk/document-library/delivery-of-respiratory-care/spirometry/spirometry-in-practice-a-practical-guide-(2005)/

- Asthma Handbook
- http://www.asthmahandbook.org.au/diagnosis/adults/initial-investigations/lung-function

- COPD-X Plan- Confirm, Optimise, Prevent, Develop, manage eXacerbations
- http://copdx.org.au/copd-x-plan/the-copd-x-plan-pdf/