opinion

IPCRG Opinion Nº 1

GPIAG Opinion Nº 1(v2)

Spirometry

Spirometry is the gold standard for the diagnosis, assessment and monitoring of COPD,[1] and may assist the diagnosis of asthma.[2] It can also contribute to the diagnosis of other causes of dyspnoea.

Which Spirometer?

Ideally, a spirometer should have a graphical display to allow technical errors to be detected. It should be able to produce a hard copy.

Regular calibration is essential. Some spirometers need to be calibrated before each session using a calibration syringe. Others hold their calibration between annual services. Check manufacturers' instructions.

Three types of spirometer are commonly used in primary care:

- Small, hand held meters which provide digital readings. These are the cheapest option and small enough to fit into a medical bag, but the lack of graphs can make it difficult to judge when a blow is complete. Predicted charts and a calculator will be needed to interpret the results.
- Portable meters with integral printers. These are more expensive but they will undertake all the calculations, including reversibility. Small displays of the volume time graph help monitor the blow and the printout includes a flow volume loop.
- Systems designed to work with a computer which will display a graph, calculate predicted and reversibility and provide a print-out. Integral memories allow data to be recorded outside the practice and uploaded when convenient.

How is spirometry performed?

Starting with full inspiration the patient blows out as hard and fast as possible until the lungs are 'empty'.

Sit or stand? Sitting is safer for the elderly and infirm, though standing may give better readings.

Three satisfactory blows should be performed:

- The blow should continue until a volume plateau is reached. This may take more than 12 seconds in people with severe COPD (in whom a slow, unforced manoeuvre may give a more accurate assessment of vital capacity).
- FVC and FEV_1 readings should be within 5% or 100ml
- The expiratory volume-time graph should be smooth and free from irregularities.

Reversibility tests

Reversibility tests involve measuring spirometry before and after treatment and can help distinguish between COPD and asthma (but note that spirometry may be normal in stable asthma).

Preparation of the patient:

The patient's condition should be stable (ie at least 6 weeks since an exacerbation).

Before a bronchodilator reversibility test the patient should stop their short acting $\beta 2$ agonist for 6 hours, long acting bronchodilator for 12 hours and theophyllines for 24 hours.

Procedure

- Perform baseline spirometry
- *Bronchodilator reversibility:* Administer bronchodilator (at least 400mcg salbutamol, e.g. 5mg by nebuliser). Perform post bronchodilator spirometry after 15 minutes.
- *Steroid reversibility:* A steroid trial (30 - 40mg daily for 2 weeks or 1,000 ug of ICS for three months) may be appropriate. An increase in FEV_1 of >12% and >200mls is significant. An increase >20% and >400mls suggests a diagnosis of asthma.

Training

Poorly performed spirometry produces misleading results. Training for operators, with regular updates and quality audits are fundamental.

Training courses

- Spirometry manufacturers can provide training in the use of their equipment. Some run spirometry courses.
- Most COPD training courses include training in spirometry.

References:

1. Global Strategy for the diagnosis, management and prevention of chronic obstructive pulmonary disease. GOLD Workshop summary.: updated 2003. Available from http://www.goldcopd.com

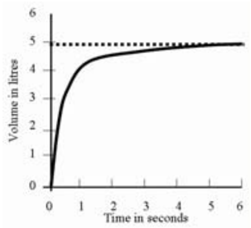
2. Global Strategy for Asthma Management and Prevention GINA Workshop Report: updated November 2003. Available on http://ginasthma.com/

A guide to interpreting spirometry

i) Normal spirometry

The Forced Vital Capacity (FVC) of the lung is the volume of air that can be forcibly expelled from the lung from maximum inspiration to maximum expiration.

Normal

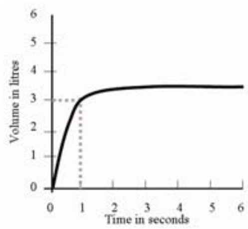


Male, 49yrs, 180cm
FVC = 4.90 litres

Predicted FVC = 4.95litres
%predicted = 99%

Forced Expiratory Volume in 1 second = FEV_1. The FEV_1 is the volume of air that can be forcibly expelled from maximum inspiration in the first second.

Normal

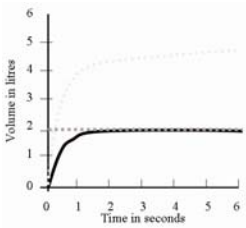


Female, 33yrs, 165cm
FEV_1 = 3.20 litres

Predicted FEV_1= 3.03litres
%predicted = 105%

ii) Abnormal spirometry is divided into restrictive and obstructive ventilatory patterns

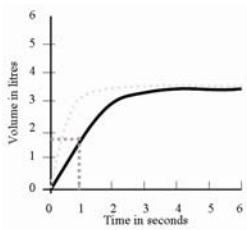
Restrictive: due to conditions in which the lung volume is reduced, eg fibrosing alveolitis, scoliosis. The FVC and FEV_1 are reduced proportionately.



Male, 49yrs, 180cm
FVC = 2.00 litres
(40% predicted)

FEV_1 = 1.80 litres
(45% predicted)

Obstructive: due to conditions in which the airways are obstructed eg asthma or COPD. The FVC and FEV_1 are reduced disproportionately.



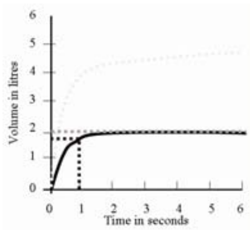
Female, 33yrs, 165cm
FVC = 3.50 litres (98 % predicted)

FEV_1 = 1.8litres (58 % predicted)

Severity of COPD: FEV_1 as a %predicted may be used to classify the severity of COPD. National guidelines vary, but many use the levels of FEV_1<80%, <50%, or <30% predicted to arbitrarily define mild, moderate or severe disease.

iii) Forced expiratory ratio (FEV_1/FVC ratio, or FEV_1%)

The FEV_1/FVC ratio is the FEV_1 expressed as a percentage of the FVC (or VC if that is greater): ie the proportion of the vital capacity exhaled in the first second. It distinguishes between a reduced FEV_1 due to restricted lung volume and that due to obstruction. Obstruction is defined as an FEV_1/FVC ratio less than 70%.

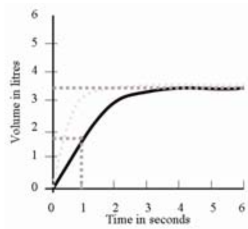


FVC = 2.00 litres (40% predicted)

FEV_1 = 1.80 litres
(45% predicted)

FEV_1/FVC ratio = 90%

Restrictive ventilatory pattern FVC reduced <80%
FEV_1 reduced
FEV_1/FVC ratio normal



FVC = 3.50 litres (98 % predicted)

FEV_1 = 1.80 litres (58% predicted)

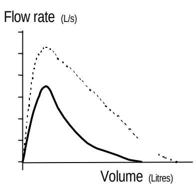
FEV_1/FVC ratio = 51%

Obstructive ventilatory pattern FVC normal or reduced
FEV_1 reduced <80%
FEV_1/FVC ratio reduced <70%

iv) Flow volume loops

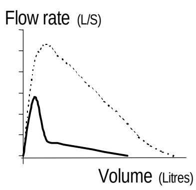
This is the same forced expiration converted electronically to illustrate the flow rate as the lung empties. The x axis represents volume - from full inspiration to full expiration: The y axis represents the flow rate. The shape of the flow volume loop depends on the mechanical properties of the lung and the shape can give important clues about the diagnosis. The dotted line is a normal curve.

Asthma



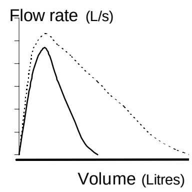
Typically the curve is a comparatively smooth concave shape as the airway obstruction is relatively stable throughout expiration

COPD



Typically the curve is angled as the damaged lungs in COPD collapse with forced expiration

Restrictive



Typically the curve is a normal height, but very steep as the lung volume is decreased

Date of Preparation: September2004 **Authors**: Dr Alan Kaplan, Canada; Dr Hilary Pinnock, UK **Editor**: Dr Mark Levy, General Practice Airways Group

Websites: http://www.gpiag.org, http://www.theipcrg.org

The GPIAG is a registered charity (Charity Number: 1098117) and a company limited by guarantee (Company number 4298947) *Registered Offices* 21-27 St Paul's Street, Leeds, West Yorkshire, LS1 2ER

The IPCRG is a is a registered charity (SC No: 035056) and a company limited by guarantee (Company number 256268) *Registered Offices*: Department of General Practice and Primary Care, Foresterhill Health Centre, Westburn Road, Aberdeen, AB25 2AY

Address for Correspondence: GPIAG, Smithy House, Waterbeck, Lockerbie, DG11 3EY, UK

Telephone: +44 (0)1461 600639 Facsimile: +44 (0)1461 207819 Email: info@gpiag.org