IPCRG - Desktop Helper
PCRS-UK - Opinion No.1 (v4)

Desktop Helper

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 are the cheapest option. However, these lack a visual display to assess the quality of the blow, and cannot print hard copies and/or allow data transfer into electronic medical records.[3]
- Portable meters with integral printers are more expensive but 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.

Small 'FEV_1 meters' are not spirometers, though they may be useful as a screening tool to identify people who should be assessed by spirometry.[4]

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 β2 agonist for 6 hours, long acting bronchodilator for 12 hours and theophyllines for 24 hours.

How is spirometry performed?

Sitting is safer for the elderly and infirm, though standing may give better readings. Using nose clips, or asking the patient to pinch their nose, prevents them inhaling whilst performing the test. Three satisfactory blows should be performed:

Two types of blow are performed. Firstly the 'relaxed' vital capacity (VC) and then the forced vital capacity (FVC). A significant difference between the VC and FVC indicates air trapping: use the larger figure to calculate the ratio (see page 2)

- **VC**: Starting with full inspiration, the patient blows out in a relaxed way, similar to a heavy sigh until the lungs are empty. Three blows shows be performed of which at least two should be within 5% or 100mls.
- **FVC**: Starting with full inspiration the patient blows out as hard and fast as possible until the lungs are 'empty'. Three blows should be performed, of which at least two should be within 5% or 100mls. When looking at the volume time graph the blow should continue until a volume plateau is reached. This may take more than 12 seconds in people with severe COPD.
- 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).

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 1,000ug of inhaled steroids for three months) may be appropriate.

People with COPD may have a significant increase in FEV_1 (> 200mls and >15%) but a substantial increase in FEV_1 (> 400mls) suggests a diagnosis of asthma.[2]

Training

Poorly performed spirometry produces misleading results. Training for operators, with regular updates and quality audits are fundamental.[3]

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, and respiratory training organisations provide spirometry courses.
- In-depth training is often available from national technical associations such as SpiroTrec, Canada and Association of Lung Function Technicians, UK.

References

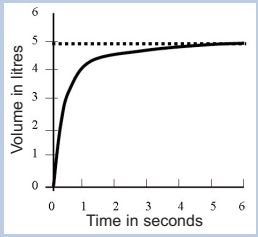
1. Global Strategy for the diagnosis, management and prevention of chronic obstructive pulmonary disease. GOLD Workshop summary.: updated 2003. Available from http://www.goldcopd.com
2. Global Strategy for Asthma Management and Prevention GINA Workshop Report: updated November 2003. Available on http://ginasthma.com/
3. Mark L Levy, Philip H Quanjer, Rachel Booker, Brendan G Cooper, Steve Holmes, Iain Small. Diagnostic Spirometry in Primary Care: Proposed standards for general practice compliant with American Thoracic Society and European Respiratory Society recommendations. *Prim Care Respir J* 2009;**18**(3):130-147 DOI: http://dx.doi.org/10.4104/pcrj.2009.00054
4. Price D, Crockett A, Arne M, Garbe B, Jones RCM, Kaplan A, Langhammer A, Williams S, Yawn BP. Spirometry in primary care case-identification, diagnosis and management of COPD. *Prim Care Resp J* 2009;**18**(3):216-223. DOI: http://dx.doi.org/10.4104/pcrj.2009.00055]

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

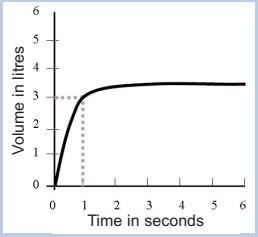


Male, 49yrs, 180cm
FVC = 4.90 litres

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

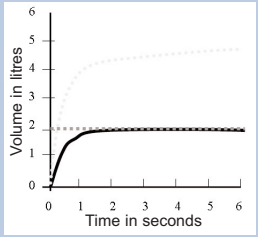


Female, 33yrs, 165cm
FEV_1 = 3.20 litres

Predicted FEV_1 = 3.03litres
%predicted = 105%

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

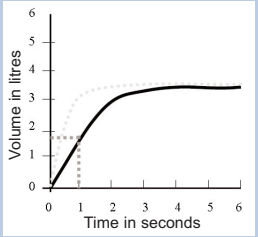
Restrictive: due to conditions in which the lung volume is reduced, eg fibrosing alveolitis, scoliosis. The FVC and FEV_1 are reduced proportionately.



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.



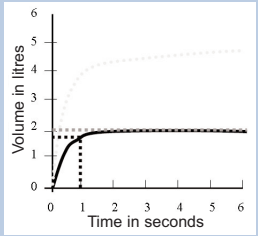
Female, 33yrs, 165cm
FVC = 3.50 litres
(98% predicted)

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%.



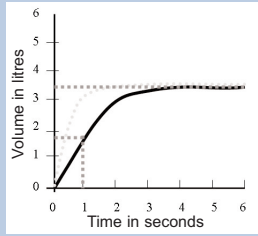
FVC = 2.00 litres (40% predicted)

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%

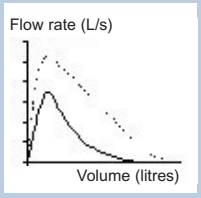
Obstructive ventilatory pattern

FVC normal or reduced
FEV_1 reduced <80%
FEV_1/FVC ratio reduced <70%

iv) Flow volume loops

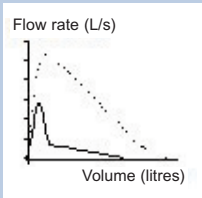
This is the same forced expiration converted electronically to illustrate the flow rate as the lung empties. The x axis represents volume - from full inspiration to full expiration: The y axis represents the flow rate. The shape of the flow volume loop depends on the mechanical properties of the lung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

Asthma



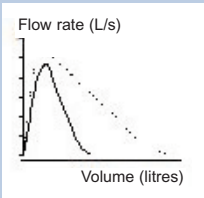
Typically the curve is a comparatively smooth concave shape as the airway obstruction is relatively stable throughout expiration

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: September 2004 **Author**: Dr Alan Kaplan, Canada; Dr Hilary Pinnock, UK **Editor**: Dr Mark Levy, Primary Care Respiratory Society
Date Modified: March 2010 **Author**: Dr Hilary Pinnock, UK; Mrs Jacqui Cooper, UK **Editor**: Dr Mark Levy, Primary Care Respiratory Society
Websites: http://www.pcrs-uk.org, http://www.thepcrj.com **Email**: info@pcrs-uk.org

Address for Correspondence: PCRS-UK, Smithy House, Waterbeck, Lockerbie, DG11 3EY, UK **Telephone:** +44 (0)1461 600639 **Facsimile:** +44 (0)1461 207819