

# Procedure for the assessment of lung function with spirometry

**Spirometry records breath movements, inhalation and exhalation, and is integral to the management of lung disease, alongside good history taking and careful documentation. Tests can indicate a patient's optimal response to treatment or triggers, and the rate of decline in lung function. It is useful to detect the presence of lung disease, those susceptible to developing lung disease and to classify patients into severity classifications to optimise management.**

**Measurements used in spirometry** Forced expiratory volume (FEV) gives a measurement of the volume of air exhaled in a given time – often 0.5, 1, 2, 3, 4 or even 6 seconds. At 1s, this is referred to as FEV<sub>1</sub>. On average, a healthy person can exhale more than 80 per cent of the air in the first second. Readings of FEV<sub>1</sub> can be used to classify lung disease when compared with predicted values for age, sex, height and ethnic origin (British Thoracic Society, 1997):

- Mild: FEV<sub>1</sub> = 60–79 per cent;
- Moderate: FEV<sub>1</sub> = 40–59 per cent;
- Severe: FEV<sub>1</sub> < 40 per cent.

Vital capacity (VC) is another useful measure in determining patients' lung status. Forced vital capacity (FVC) represents the total amount of air exhaled at force from a maximum inhalation (total lung capacity) to maximum exhalation (residual volume), measured against time. Relaxed Vital Capacity (VC) is the volume from maximal inspiration to maximal expiration performed slowly, and not measured against time.

The ratio FEV<sub>1</sub>/FVC (the amount of air exhaled at one second compared with the total volume of either the FVC or VC, whichever is the greater) is often expressed as FEV<sub>1</sub>% and can be used to distinguish between restrictive disease, for example, pulmonary fibrosis; and obstructive disease, for example, asthma (Fig 1).

A restrictive pattern affects lung expansion and is characterised by a low FEV<sub>1</sub>, a low FVC and a high FEV<sub>1</sub>/FVC ratio. An obstructive pattern is one which affects the rate at which air can be expelled from the lungs and is characterised by a reduced FEV<sub>1</sub>, normal FVC and a low FEV<sub>1</sub>/FVC ratio.

## Preparation of the patient for spirometry

Nurses should be familiar with the type of spirometer they are using. Patients should be informed about spirometry to aid adequate preparation for the test and to enable the patient to give informed consent. Many variables may affect the test – before it, the patient should avoid:

- Smoking for 24 hours;
- Drinking alcohol for at least four hours;
- Vigorous exercise for at least 30 minutes;

- Wearing any tight clothing;
- Eating a large meal for at least two hours;
- Taking short-acting bronchodilators for four hours;
- Taking long-acting beta-2-agonist inhalers for 12 hours;
- Taking slow-release medicines that affect respiratory function, and theophylline-based drugs for 24 hours (ARTP/BTS, 1994).

**Procedure for spirometry** The ARTP/BTS (1994) guidelines recommend the following steps:

- The patient should be seated in a chair with arms;
- Two relaxed measurements of vital capacity should be performed first, (the patient should use nose clips for this procedure to prevent air leakage from the nose), followed by three forced vital capacity measurements;
- A large breath to full inspiration is taken through mouth;
- The mouthpiece is placed into the patient's mouth and the patient is asked to place his or her lips and teeth around the mouthpiece to form a tight seal;
- For the relaxed VC, the patient breathes out at a comfortable speed, but for the FVC the patient should breathe out hard and quickly until all air is expelled;
- The FVC should take 6s, but in some patients with obstructive breathing patterns it can take up to 15s;
- At least 30s should be left between blows (exhalations using the spirometer) to enable the patient to recover;
- A minimum of three and a maximum of eight blows should be attempted at any one time.

It is vital that patients inhale completely, to total lung capacity, and continue to exhale until they have fully emptied their lungs (to residual volume) so that a low vital capacity is not recorded due to poor effort. It is vital to observe a patient's technique and the shape of the flow/volume or volume/time curves to detect poor effort.

**Reproducibility** Spirometry equipment should be checked regularly, using the manufacturers' instructions, to ensure readings are accurate. A log should be kept to record any verification or calibration checks performed.

The printout of each set of measurements recorded with a patient should be examined to ensure that the tests are consistent (reproducible). The following points should be assessed (ARTP/BTS, 1994):

- At the start of the test (time = zero), there should be a steep rise in the curve (Fig 1);
- The results of two FVC tests performed by the same patient should be within five per cent and 100ml of each other (to demonstrate consistency);
- Equipment should be capable of recording up to 14s; up to a volume of 8l (litres); or up to a flow rate of 15l/s;
- Calibration/verification of the machine should take

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**Spirometry helps to determine the severity and pattern of lung disease. It is an essential tool to enable appropriate management and diagnosis of lung disease. Kath Cooper and Pat Mitchell describe the procedure for spirometry, based on guidelines by the ARTP/British Thoracic Society (1994), and The Global Initiative for Chronic Obstructive Lung Disease (2001)**

## KEY WORDS

Standardisation  
Reproducible  
Technique

## FURTHER INFORMATION

**The Respiratory Education and Training Centre (RETC)** offers courses in spirometry at basic and diploma level. For information, contact University Hospital Aintree, Training and Development Centre, Lower Lane, Liverpool L9 7AL; tel: 0151 529 2598.

**The Association of Respiratory Technicians and Physiologists (ARTP)** offers the ARTP/BTS certificate in spirometry. For more information, contact Jackie Hutchinson, ARTP administrator, 202 Maney Hill Road, Sutton Coldfield, West Midlands B72 1JX; tel: 0121 241 1611.

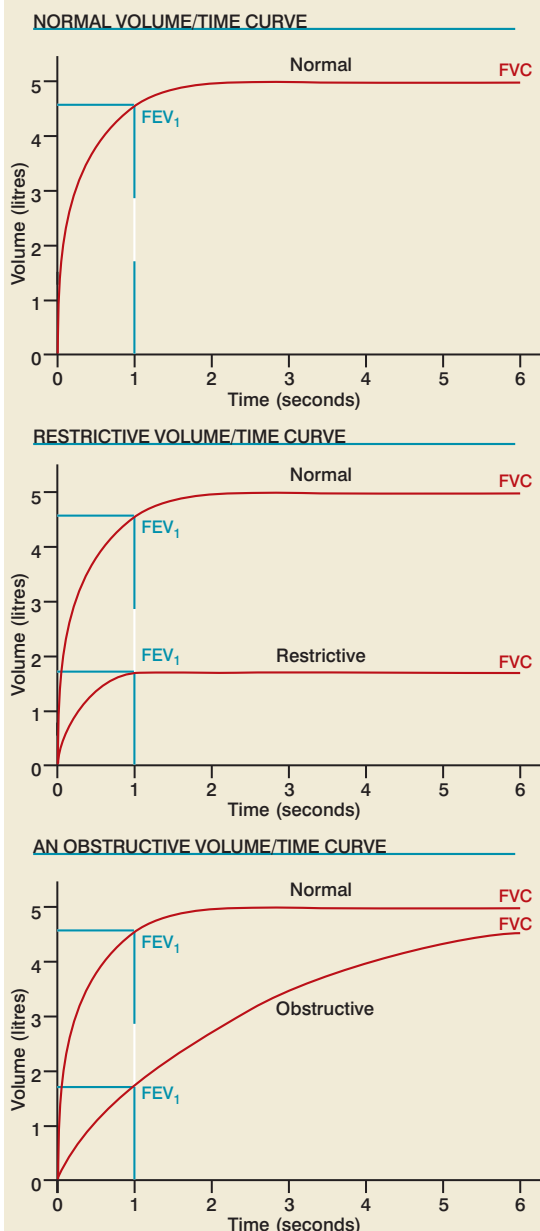
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place daily or at the start of a session;

■ The end point of the test should be when less than 0.05l has been exhaled in a 2s period; if the test exceeds 15s; or if the operator has to end the test for clinical reasons.

**FIG 1. NORMAL, OBSTRUCTIVE AND RESTRICTIVE SPIROMETRY RESULTS**



**Reporting results** Careful and accurate reporting is vital to ensure that patients are diagnosed and treated correctly. The best FEV<sub>1</sub> and FVC results should be selected from three reproducible blows (these need not be from the same manoeuvre as long as results are within 100ml and five per cent of each other). The FEV<sub>1</sub>/FVC ratio should be calculated from the best VC reading, whether this is a relaxed or a forced manoeuvre. Reference values and ranges should be reported.

**Reversibility** This refers to an improvement in FEV<sub>1</sub> after an intervention such as a drug treatment. About 10–20 per cent of patients with COPD will respond to steroid therapy – the largest response is usually seen in patients who have a positive response to bronchodilators. The response of patients with COPD to steroids is under review and may point to a need for prolonged trials of inhaled steroid treatment for a period of 12 weeks (Global Initiative on Chronic Obstructive Lung Disease, 2001).

A change in FEV<sub>1</sub> of more than 200ml and 15 per cent compared with previous readings is suggestive of a positive response to a particular medication, for example a bronchodilator, and not a change in the airway size due to normal fluctuation (Sourk and Nugent, 1983).

Patients who show improvements with bronchodilators should be considered for a steroid reversibility trial; the post-bronchodilator FEV<sub>1</sub> and the post-steroid FEV<sub>1</sub> should be assessed and compared (American Thoracic Society, 1991). Subsequent FEV<sub>1</sub> recordings should be made after administration of bronchodilators to inform further treatment (Hansen et al, 1999).

Many patients in the moderate and severe stages of COPD show a reduction in exacerbation rates even if they have had a negative steroid trial, and this should be considered in management strategies (BTS, 1997).

The Gold guidelines from The Global Initiative for Chronic Obstructive Lung Disease (2001) advocate several changes to the interpretation and classification of spirometry. They suggest that many patients with COPD may be treated as patients with asthma because they have a degree of reversibility to their airway function. They also suggest that the FEV<sub>1</sub>/FVC ratio is a more sensitive test, to be considered when judging if reversibility is partial, as in COPD, or complete, as in asthma. Current guidelines may, therefore, underestimate the severity of the disease when only FEV<sub>1</sub> is considered (BTS, 1997).

**Conclusion** Spirometric investigations are not simple to perform, but they are valuable for assessing lung function and diagnosing lung disease. An increasing number of general practices are purchasing spirometers, so adequate training of staff is essential. ■