

Data you can rely on.  
People you can trust.



## White Paper

Bernard Garbe, Vitalograph

## The role of spirometry

Office spirometry is a physiological test measuring exhaled volumes of air as a function of time. It is of irreplaceable value as a test of respiratory health in the same way that ECG and BP provide important information about general cardiovascular health. Spirometry gives an objective measurement of lung mechanics to help make or exclude a diagnosis, though a diagnosis cannot be made on the basis of spirometry alone.

Spirometry is recommended primarily for helping to diagnose and manage asthma and COPD, as well as a range of other diseases which may affect respiration. Spirometry is, however, only one way of objectively assessing COPD disease severity. Other measures, such as the BODE Index and quality of life assessment, help to build a more complete picture.

## Types of Spirometers

There are many different types of spirometer with a range of features and prices:

- PC spirometers make your desktop or laptop PC into a spirometer when you run the software application provided with the device. Spirotrac is the most widely used spirometry software and also is capable of many other types of medical examination.
- Hand-held spirometers are pocket sized, often have a small real-time graphical display and provide reports and/or synchronise data with a PC. They are battery operated and store data so can be used inside or outside the office.
- Desktop spirometers typically have a built-in display and printer and produce a report on thermal paper. They will often also send data to a PC for electronic reports to be archived, typically as a PDF.
- Medical Workstations are stand-alone medical devices that can also be linked to your office network. A range of hardware can be connected to the device for different physiological measurements, including spirometers, BP, ECG, SpO<sub>2</sub>, medical scales etc. One medical workstation, the Vitalograph COMPACT, has a built-in spirometer.
- Respiratory monitors and screeners are not true spirometers because they cannot produce spirograms. Their measured indices are limited, though they always include FEV<sub>1</sub>. Some high quality respiratory monitors such as the copd-6 can give the FEV<sub>1</sub> Ratio and percent predicted. These

are widely used in primary care for spirometry case selection because they are very small and inexpensive, perfect in a doctor's bag for a two minute screening test.

- Volume displacement spirometers are simple and fast to use and are highly accurate. Although designed in the 1960s as office spirometers the fact that they need to hold 8-L of air makes them necessarily larger than flow-sensing spirometers so are rarely found in primary care today. They are useful for training and are used in lung function laboratories.
- Peak Flow Meters are also not true spirometers and indeed a different standard applies to them: ISO 23747 (The spirometer standard is ISO 26782). Peak flow meters can be mechanical or electronic.

## The role of spirometry

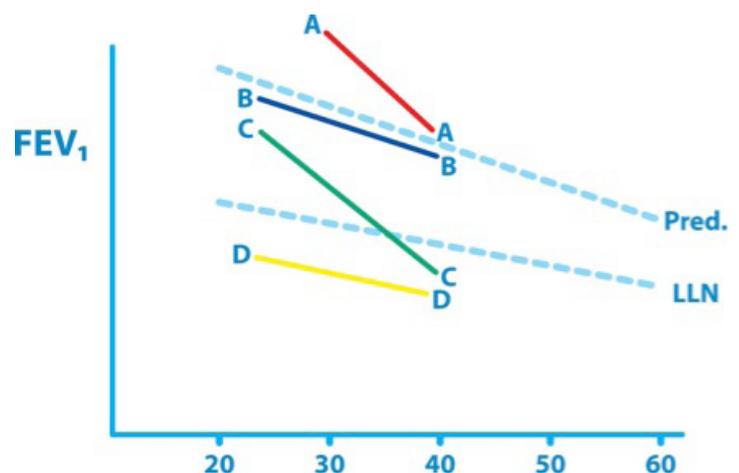
The standard spirometry test is a maximal forced exhalation (with greatest effort) after a maximal deep inspiration (completely full lungs). Several indices can be derived from this blow.

- FEV<sub>1</sub> – Forced Expiratory Volume in One Second – the maximum volume of air that the subject is able to exhale in the first second. This is the single most important index.
- FVC – Forced Vital Capacity – the total volume of air that the subject can forcibly exhale. This can take as long as 20s in subjects with obstructive lung disease.
- FEV<sub>6</sub> – Forced Expiratory Volume in Six Seconds – the maximum volume of air that the subject is able to exhale in 6s. FEV<sub>6</sub> is a useful and validated surrogate for FVC.
- FEV<sub>1</sub>/VC – the ratio of FEV<sub>1</sub> to VC, FVC or FEV<sub>6</sub> (whichever larger) expressed as a unitless ratio - not a percentage to avoid confusion with percent of predicted.

Population predicted values are commonly used to compare to the current test results. This can have some value in a few specific applications, but mostly 'predicted values' create a smokescreen blinding the practitioner from the real valuable data within the spirometry report. Too often the opportunity for intervention or recognition of lung damage is lost because the spirometry test report appears to show that the data are in 'normal range, above 80% of predicted'. The rate of decline of the FEV<sub>1</sub> should be the focus of the practitioner. If a previous measure of FEV<sub>1</sub> is available, 'predicted values' are relevant only to help determination of a normal rate of decline.

It is possible to find smokers with a rate of decline of FEV<sub>1</sub> of >100ml per annum (normal is about 30ml) whilst they are still above 'normal range'. If the rate of decline is not recognised, such individuals are simply classified as 'normal' (for a while – it could be years or even decades before they present with dyspnoea).

Pictured right is a representation of the well known 'Fletcher-Peto diagram' illustrating the natural history of COPD. FEV<sub>1</sub> is shown against age in years. It illustrates that an abnormal decline in lung function may not be detected for decades if the subject starts off with normal lung function.



Subject B is normal and D could also be normal, falling into the 5% of 'normals' below LLN. Subject C is detected as abnormal after 2 decades. Subject A is abnormal (probably a smoker) but is not detected without serial measurement and plotting of FEV1.

Modern spirometers (not screeners or monitors) show the Z-score (or SDS) and the LLN (lower limit of normality) instead of 'percent of predicted'. This is far better, but still assumes that the test subject is in the same population as the 'predicted value' population.

## Quality Control

Attention to equipment quality control and calibration is an important part of good practice. At a minimum the requirements are as follows:

- Maintain a log of accuracy check results
- Archive the documentation of the annual service and any repairs
- Record the software issue, updates or changes
- Perform QC checks before resuming use if equipment malfunction is suspected
- Wash your hands

## Prepare the test subject

- Explain the test
- Ask about smoking, recent illness, medication use, etc.
- Loosen any tight clothing
- Measure weight and height without shoes
- Instruct and enthusiastically demonstrate the test to the subject
- Demonstrate correct posture with head slightly elevated
- Show how the mouthpiece is inserted into the mouth, not like a trumpet
- Demand complete and rapid inhalation and maximum exhalation

## Commence testing

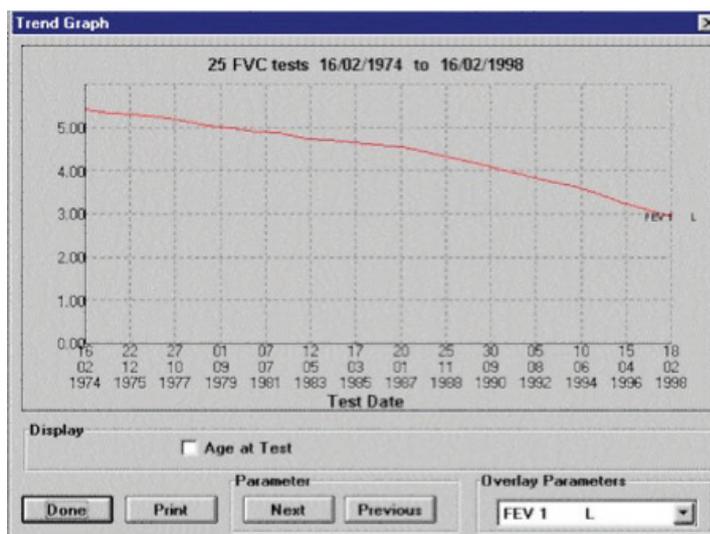
- Two slow vital capacity (VC) tests are recommended before FVC
- Commence FVC testing, minimum of three usable efforts
- If obstruction is present administer bronchodilator and wait for effect
- Perform post BD testing
- The spirometric criterion required for a diagnosis of COPD includes FEV1/FVC ratio below 0.7 after the use of a bronchodilator.

**Note:** *The procedure above cannot be conducted by an untrained operator.*

## Opportunistic Population Screening

The need to confirm diagnosis of COPD early is increasingly appreciated by primary care physicians in whose hands the ability to make improvements in early diagnosis largely rests. Case-finding of patients with symptoms of lifestyle limitation is probably the most practical way to achieve early diagnosis. Case finding can be achieved quickly, easily and cost effectively by screening people who are at risk of COPD using low cost respiratory monitors. To make a good assessment FEV1, the FEV1/FEV6 ratio and FEV1 as a percent of predicted is required. All this might sound complicated,

but modern respiratory monitors can do all this automatically in a simple two minute test of respiratory function. Using FEV6 instead of FVC makes it much simpler to get a repeatable reading and for screening purposes is perfectly adequate to determine the presence and severity of airways obstruction.



### **Spirometry is only as good as the person performing the test**

Effective spirometry testing is highly dependent on the skill of the person doing the test and their ability to coach the subject through the test. Spirometry training and refresher courses are vital to good spirometry.