



# **SPIROMETER USERS' AND BUYERS' GUIDE**

**Fully Revised 2011**

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*Endorsed by:*



Australian and New Zealand  
Society of Respiratory Science Ltd



The Thoracic Society of Australia  
and New Zealand Ltd

**Recommended citation:**

Burton D, Johns DP, Swanney MP. *Spirometer Users' and Buyers' Guide*.  
Melbourne: National Asthma Council Australia, 2011.

**First published 2005**

**Minor revision 2007**

**Fully revised 2011**

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*First edition developed with support from the Australian Government Department of Health and Ageing*

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## Foreword

The importance of spirometry for identifying and managing patients with respiratory disease is well established and there is an increasing call for primary care physicians to include spirometry in their practice. However, the large number of spirometers currently available in Australia makes it difficult for those with little experience to determine which spirometer best suits their practice needs.

The aims of this *Spirometer Users' and Buyers' Guide* are to provide:

- a summary of the specifications, features and primary supplier of spirometers on the Australian market to assist purchasers select the most appropriate instrument for their needs, and
- general information about the measurement and application of spirometry in the primary care clinical setting.

The first *Spirometer Users' and Buyers' Guide* was published in February 2005. This version was compiled in June 2011.

This guide is not intended to be a comprehensive book on spirometry. A reading list is included for those wishing to obtain more detailed information about spirometry and it is recommended that those wishing to measure and interpret spirometry attend a spirometry training course.

We wish to acknowledge the cooperation and thank each of the Australian distributors for supplying data used to compile the tables of spirometers.

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July 2011

## SECTION 1

### SPIROMETRY AND ITS MEASUREMENT

#### Introduction

The most common physiological abnormality affecting lung function is impaired ventilatory capacity due to airway narrowing. Spirometry directly and objectively assesses the functional consequences of airway narrowing and for this and the following reasons is the most widely used test of lung function:

- *spirometry* is a safe and relatively quick test to perform and with correct coaching almost all patients attending general practice are able to correctly perform the test
- *spirometry* is reproducible and the results are available immediately
- *spirometry* results can be compared with well developed normal reference values, allowing the detection and quantification of abnormal lung function
- *spirometer* performance requirements and testing methods have been standardised.

Clinical guidelines include the measurement of spirometry as part of the diagnosis and management of the most common chronic respiratory diseases, namely asthma and chronic obstructive pulmonary disease (COPD). In both of these chronic diseases the hallmark physiological characteristic is *airflow obstruction* and spirometry is the gold standard for detecting obstruction and grading its severity.

It is because spirometry is now recognised as an essential clinical tool in the diagnosis and management of asthma and COPD that countries throughout the world are encouraging primary care physicians to include it in their clinical practice.

Asthma and COPD are major public health problems with Australia among the worst affected. They are the third leading cause of disability and the fifth leading cause of premature mortality. Currently in Australia about 1 in 9 children and 1 in 10 adults have asthma and recent data suggests that 1 in 9 people aged 40 years and older have COPD. The health costs associated with the care of people with asthma is currently estimated at about \$700 million per year. The health system costs of the more chronically disabling and progressive COPD has been estimated at nearly \$8.8 billion when the burden of lost productivity, absenteeism, low employment and premature death are costed (Access Economics, 2008). Unfortunately, the prevalence of these diseases is expected to increase substantially in the coming years, as will the burden of these diseases in terms of health system and economic costs.

Despite these disturbing statistics, only approximately 30% of patients with demonstrable airflow obstruction and who are under the care of primary care physicians have had their lung function assessed with spirometry. This means that as many as 70% lack a confirmed diagnosis based on measurement of spirometry and are not being monitored objectively for optimising interventions.

#### What is Spirometry?

Spirometry is an objective and reproducible test of lung function that measures how much and how quickly air can be moved into and out of the lungs. The measurements are made using a spirometer. The essentials for quality spirometry rely on:

- the use of an accurate spirometer that meets the required international standards
- active coaching to ensure the patient performs the test correctly
- ongoing quality assurance
- adequately trained operators.

#### What is a Spirometer?

A spirometer is an instrument used to measure respired volumes and flows (i.e. spirometry). Many spirometers are able to measure both inspiratory and expiratory airflow.

## Why Measure Spirometry?

When correctly performed, spirometry using an accurate spirometer provides:

- rapid and objective assessment of airflow obstruction and restrictive conditions
- differentiation between asthma and COPD
- early detection and monitoring of disease progression (e.g. COPD)
- quantitative assessment of the severity of airflow obstruction
- information to incorporate guideline recommendations for therapy based on asthma and COPD severity (Asthma: [www.nationalasthma.org.au](http://www.nationalasthma.org.au); COPD: [www.copdx.org.au](http://www.copdx.org.au))
- quantitative assessment of the response to therapy
- population case finding to detect airflow obstruction – especially patients with symptoms and in particular in smokers and ex-smokers
- encouragement and motivation for patients to quit smoking, especially if spirometry is abnormal (provides a ‘teachable moment’)
- feedback to the patient about their disease and effect of medication
- more accurate and comprehensive assessment than peak flow, especially in people with COPD.

## Why Measure Spirometry in General Practice?

The primary care physician should use spirometry to assess patients with respiratory symptoms and to screen for COPD.

Primary care physicians are in a unique position to monitor the respiratory health of the community. The inclusion of spirometry as a routine test, especially in patients at risk of respiratory disease (e.g. smokers), will lead to earlier detection of respiratory disease and more effective intervention and treatment.

Ninety percent of non-asthmatic patients with significant airflow obstruction have COPD. In addition, COPD is characterised by an accelerated decline in spirometric values. The disease progresses slowly and the early signs (e.g. cough and sputum) are often ignored or are not significant enough to prompt the patient to seek treatment. Consequently, a diagnosis is often not made until about half of the lung’s large reserve ventilatory capacity is already lost. Because there is a close relationship between the risk of COPD and the intensity and duration of smoking, spirometry is a very important test for the early detection of COPD in smokers. When provided with evidence of airflow obstruction, patients are more likely to cease smoking and this will reduce the rate of FEV<sub>1</sub> decline and thus modify the natural history of the disease. Although there is the possibility that a finding of normal spirometry in a smoker may reinforce their smoking habit, such findings can be used as ‘teachable moments’ when the patient has increased awareness of the risks.

Measuring spirometry in a patient with asthma helps to detect and quantify the disease and to assess the effectiveness of therapy.

If the results of spirometry are abnormal but inconclusive it is advisable to refer the patient to a respiratory function laboratory or a respiratory physician for further assessment.

## Medicare Rebate and Asthma Cycle of Care (SIP)

Doctors who perform spirometry before and after the administration of a bronchodilator can claim under Medicare item 11506. The *Asthma Cycle of Care* provides a SIP for practices that complete two visits for asthma management within 12 months in patients with moderate to severe asthma, according to the specified criteria (<http://www.health.gov.au/internet/main/publishing.nsf/Content/asthma-cycle>).

## Involvement of the Practice Nurse

Some doctors may prefer their practice nurse to perform the spirometry measurement, which is the most time-consuming part of the patient’s assessment. The doctor then interprets the spirometry result.

## Definitions of Common Spirometric Indices

- **FVC** (Forced Vital Capacity) is the maximum volume of air that can be expired during a single expiratory manoeuvre using maximal effort initiated following a full inspiration.
- **SVC** (Slow Vital Capacity) is the maximum volume of air that can be exhaled “slowly” following a full inspiration. The SVC is similar to the FVC in subjects without airflow obstruction, but is often larger in subjects with airflow obstruction.
- **FEV<sub>1</sub>** (Forced Expired Volume in one second) is the volume of air that can be forcefully expired in the first second of the FVC manoeuvre. It is a measure of how quickly full lungs can be emptied. The FEV<sub>1</sub> expressed as a percent of the predicted value is used to grade the severity of airflow obstruction.
- **FEV<sub>1</sub>/FVC ratio** is the FEV<sub>1</sub> expressed as a fraction (or percentage) of the FVC and gives a clinically useful indicator of the presence of airflow obstruction.
- **FEF<sub>25-75%</sub>** (Forced Expiratory Flow between 25 and 75 percent of the FVC) is the average expired flow over the middle half of the FVC manoeuvre. It is regarded as a more sensitive but more variable measure of narrowing of the smaller airways than provided by FEV<sub>1</sub>.
- **PEF** (Peak Expiratory Flow) is the largest expiratory flow achieved during the FVC manoeuvre.

## Contraindications

Spirometry is a very safe procedure. However, the test is physically demanding as it requires maximal patient effort with the generation of high thoracic, abdominal, intracranial and intraocular pressures. It is advisable that spirometry be delayed following:

- recent eye, brain and ear surgery
- recent thoracic and abdominal surgery
- aneurysms (e.g. cerebral, abdominal)
- unstable cardiac function
- haemoptysis of unknown cause (possible cross-infection risk e.g. TB)
- pneumothorax
- chest and abdominal pain
- nausea and diarrhoea.

Also, children younger than about 7 years may have difficulty performing the test.

## How to Perform Spirometry

Spirometry requires maximal effort from the patient and it takes time to perform quality spirometry. It is essential the procedure is carefully and clearly explained and to actively coach and motivate the patient to perform maximally. The performance of spirometry while seated upright in a chair is preferable to standing as this is the most stable position should the patient experience dizziness during the test. The seated position is also preferable for patients with urinary incontinence who may otherwise limit their expiratory effort. While it is not mandatory to use a nose clip to prevent loss of measured volume through the nose, their use is sometimes of benefit and therefore recommended.

The key steps are to urge the patient to:

- **breathe in fully** – *the lungs must be absolutely full*
- seal the lips around the mouthpiece and **immediately...**
- **blast** the air out as fast and as far as possible until the lungs are **completely** empty.
- repeat the test until **three acceptable and repeatable** (see below) results are obtained – usually up to a maximum of 8 efforts.

The largest values for FEV<sub>1</sub> and FVC from the three acceptable trials should be reported, even if they come from separate blows.

## Acceptable and Repeatable Results

The clinical value of spirometry is critically dependent on good quality results, so it is important to take time to ensure that the patient performs the tests correctly.

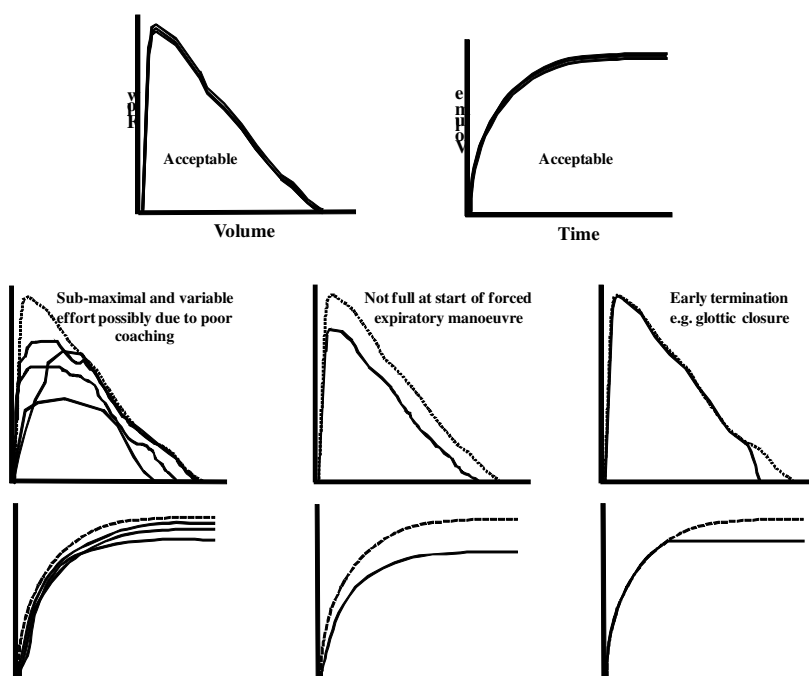
Acceptable results are those that were initiated at *full* lung inflation, and with *maximum* expiratory effort (e.g. no hesitation at the start and no pauses throughout the blow) until absolutely no more air can be expired. Common causes of poor quality spirometry are listed below and examples given in Figure 1. The results are repeatable if there is less than 150 mL variation in both FEV<sub>1</sub> and FVC between the two best acceptable blows. However, if the patient's FVC is one litre or less ( $\leq 1.0$  L) then one should aim for a variation of less than 100 mL. Repeat the test if the results are not repeatable.

A spirometer that allows you to see a graph of the flow-volume curve in *real-time* and provides alert messages about test quality makes it much easier to determine the *acceptability* of each blow. It is useful to have both flow-volume and volume-time graphic output so that the acceptability of the results can be easily judged. In addition, the screen size needs to be large enough to detect hesitations at the start of the test and identify a plateau in volume at the end of each test.

Once a testing session is completed, a comment on the patient's performance should be noted to assist with interpretation of the results.

**Figure 1**

*Examples of acceptable and poorly performed spirometry in a healthy subject  
For comparison, acceptable efforts are shown as dashed lines*



## Common Causes of Poor Quality Spirometry

- sub-maximal effort (e.g. due to poor coaching, poor volition, full bladder)
- failure to fully inflate the lungs prior to performing the forced expiration
- incomplete expiration (i.e. early termination)
- hesitation at the start of the expiration
- leaks (e.g. between the lips and mouthpiece)

- untrained (or poorly) trained staff performing the test
- inability to comprehend the instructions
- cough, glottic closure and obstruction of the mouthpiece by the tongue or teeth
- vocalisation during the forced manoeuvre.

### **Reversibility of Airflow Obstruction**

If there is evidence of airflow obstruction, spirometry is usually performed before and after the administration of a short-acting bronchodilator to assess whether the airflow obstruction can be reversed:

- perform pre-bronchodilator spirometry (see above)
- administer the bronchodilator (e.g. 4 separate puffs of salbutamol via a spacer)
- wait 10–15 minutes
- perform post-bronchodilator spirometry (as above).

If the clinical reason for performing the reversibility test was to check the patients' usual response to bronchodilator, it may be more appropriate to use the patients' usual bronchodilator device and dose. During this test it is helpful to observe the patient's normal inhaler technique and correct any errors.

The recommended criteria for a significant improvement in spirometry are at least:

*12% improvement in FEV<sub>1</sub> (and/or FVC) AND an absolute improvement of at least 200 mL*

It is important to note that in some patients the degree of reversibility can vary between clinic visits and may be reduced if the patient has taken a bronchodilator prior to testing. It is important to ask the patient when they last used their bronchodilator (short and long acting) and to take this into account when assessing the degree of reversibility. To determine the maximum response to bronchodilator, long-acting bronchodilator should be withheld for 12 hours prior to testing and short-acting bronchodilator should be withheld for 4 hours.

The absence of significant reversibility does not necessarily exclude the diagnosis of asthma.

Note that the FEV<sub>1</sub>/FVC ratio is *not* a reliable index of reversibility as the FVC can increase more than FEV<sub>1</sub> causing the FEV<sub>1</sub>/FVC ratio to decrease in the presence of a useful degree of bronchodilatation. Do not use FEF<sub>25–75%</sub> for assessing reversibility.

Reversibility may also be assessed by measuring spirometry before and several weeks after a trial of inhaled glucocorticosteroids or oral prednisone. In addition, referral for a bronchial challenge test may be indicated for some patients with asthma-type symptoms.

### **Selecting the Most Appropriate Reference Values**

Spirometric indices such as FEV<sub>1</sub> and FVC vary with age, height, gender and ethnicity. It is important to take care to *correctly enter* the patient's height, age, gender and ethnicity, otherwise the reference values will be inaccurate and this will affect the subsequent interpretation of the results.

The choice of predicted reference values against which the results are compared is important. The reference values chosen should closely match the subjects you are testing and provide statistically calculated *lower limits of normal* for each value being reported. Australian and USA reference values are available on some spirometers and these may most closely approximate the population you are testing. However, depending on the ethnic mix of people in your local environment other reference values may be more appropriate. If you are unsure which reference values to use contact your local respiratory laboratory (see below). In general, Caucasian predicted values for FEV<sub>1</sub> and FVC are usually used and the values reduced by 12-15% when testing people of other ethnic backgrounds. All age reference values have recently become available which overcome the problem of changing from adolescent to adult reference values for young people who are being monitored for their lung function.

## Infection Control

Precautions must be taken to minimise any risk of cross-infection via the spirometer. The use of low resistance barrier filters significantly reduces the risk of cross-infection and also helps protect the equipment. These filters are for single patient use so a *new* filter must be used for each patient. Some spirometers use a single patient use disposable sensor or mouthpiece. Re-useable mouthpieces must be cleaned, disinfected and dried between patients. In the case of disposable mouthpieces, a *new* one must be used for each patient.

## Quality Assurance

Accurate and reliable measurements of spirometry are very important otherwise comparison with reference normal values or previous tests is meaningless and one would have no confidence that a given result, or change over time, is real. Therefore, the practice of spirometry requires an ongoing program of refresher courses for staff performing spirometry tests to keep the quality at the required standard as well as a preventative spirometer maintenance and quality assurance regimen:

- regular cleaning
- calibration checks (consult your spirometer manual)
- equipment maintenance to ensure that the spirometer is operating correctly
- regular review to ensure ongoing test quality.

Regular validation of the calibration is ideally performed with an accurate 3 L syringe before each testing session. A very useful and practical method of assessing the *overall performance* of the spirometer is to regularly test a healthy subject. Generally, a variation of more than 5% in FEV<sub>1</sub> or FVC should alert you to a problem and the need to have your instrument checked and serviced. Using two subjects tested on alternate weeks is preferable to allow the differentiation between subject and equipment drift.

Records should be kept of each calibration and the test results from healthy subjects.

## Criteria for Spirometer Performance

The American Thoracic Society (ATS) [www.thoracic.org/statements](http://www.thoracic.org/statements) and European Respiratory Society (ERS) [www.ersnet.org/ers/](http://www.ersnet.org/ers/) have jointly published comprehensive guidelines on the minimum performance specifications for spirometers.

## Interpretive Strategies

Before interpreting results it is important to check correct entry of demographic data and to take note of comments made by the operator on the quality of the test. In addition, take into account the patient's history and indication(s) for requesting the test.

There are three classifications for abnormal spirometry:

- **Obstructive Ventilatory Defect:** characterised by reduced expiratory flows below the predicted lower limit of normal e.g. reduced FEV<sub>1</sub>/FVC ratio, FEV<sub>1</sub>, FEF<sub>25-75%</sub> or if the expiratory flow volume curve is scooped-out (see examples, Figure 2). Common examples include asthma and COPD.
- **Restrictive Ventilatory Defect:** characterised by loss of lung volume in the absence of airflow obstruction (i.e. as suggested by the SVC or FVC falling below the predicted lower limit of normal, but with normal or high FEV<sub>1</sub>/FVC ratio). Examples include interstitial lung disease, respiratory muscle weakness and thoracic cage deformities.
- **Mixed Obstructive and Restrictive Ventilatory Defect:** characterised by both airflow obstruction *and* loss of lung volume (i.e. as suggested by the FEV<sub>1</sub>/FVC ratio *and* SVC or FVC falling below the predicted lower limit of normal). This defect is relatively uncommon. An example is cystic fibrosis.

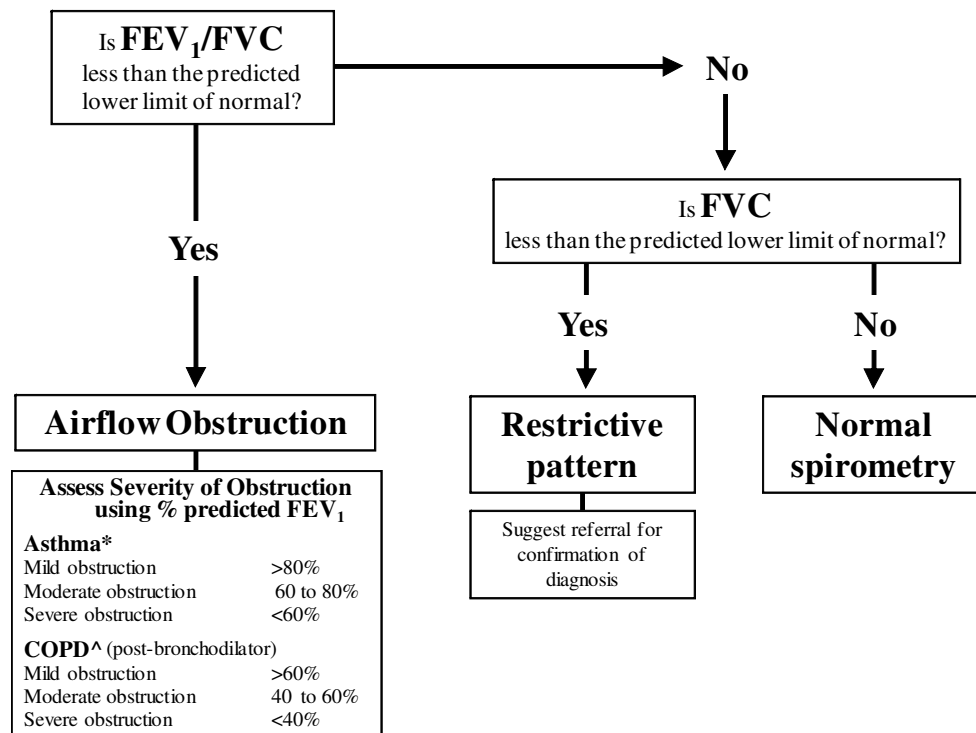
Figure 2 shows a simple algorithm to guide the interpretation of spirometry results. The decision as to whether or not the FEV<sub>1</sub>/FVC ratio and FVC are normal should be made by comparing them with their respective predicted *lower limits of normal*. A low FEV<sub>1</sub>/FVC ratio indicates airflow obstruction whereas a normal or high FEV<sub>1</sub>/FVC ratio together with a low FVC suggests a restrictive defect. A restrictive spirometric pattern should be confirmed by referral for total lung capacity measurement. A restrictive pattern on spirometric measurement is only correct in approximately 50% of patients. Normal spirometry excludes a restrictive process.

Grading the severity of airflow obstruction defect should be based on the percent predicted FEV<sub>1</sub> and *not* the FEV<sub>1</sub>/FVC ratio. The use of a *fixed* value to define the lower limit of normal (e.g. 80% of the mean predicted for FVC and 0.70 for the FEV<sub>1</sub>/FVC ratio) is *not recommended*. The use of a fixed lower limit of normal for the FEV<sub>1</sub>/FVC ratio such as <70% to identify airflow obstruction is only valid in middle-aged patients and will result in false positives in older people and false negatives in young adults.

Automatic interpretation via spirometer software is not recommended.

Additionally, certain respiratory conditions alter the shape of the flow-volume loop and it is important to learn how to recognise these. Examples are given in Figure 3.

**Figure 2**  
Guideline for spirometry interpretation



\* NAC. Asthma Management Handbook 2006: [www.nationalasthma.org.au](http://www.nationalasthma.org.au)

<sup>^</sup> COPDX Plan. Australian and New Zealand Guidelines 2010: [www.copdx.org.au](http://www.copdx.org.au)

### Asthma and COPD

In these diseases the FEV<sub>1</sub>/FVC ratio is used to detect airflow obstruction and FEV<sub>1</sub> expressed as a percent predicted to grade the severity of airflow obstruction, and these values are used in the interpretation algorithm (Figure 2).

Although both asthma and COPD are characterised by airflow obstruction, the mechanisms of each disease are different. In COPD due to emphysema, airflow obstruction is predominantly due to airway collapse whereas in asthma it is mainly due to bronchoconstriction, inflammation of the airway wall and mucous plugging. In general, spirometry improves significantly after effective treatment in asthma but not at all, or marginally, in patients with COPD although their symptoms may improve. Clinical history (e.g. wheeze, chest tightness, variable symptoms and breathlessness), age and smoking history and other exposures (e.g. occupational dusts) are also important in differentiating asthma from COPD.

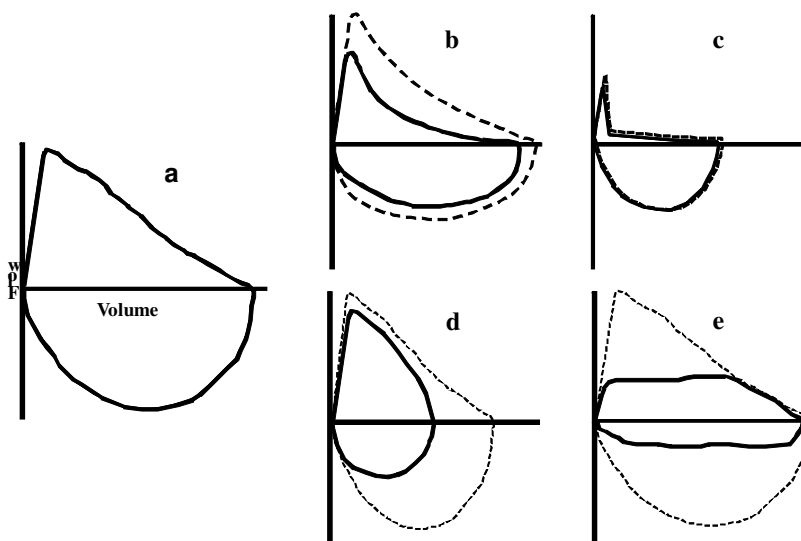
Spirometry screening of smokers and ex-smokers has been shown to enhance early detection of COPD when treatment and intervention can have a positive effect on disease progression. Furthermore, the demonstration of airflow obstruction to the patient has been shown to motivate smokers to quit.

**Figure 3**

*The shape of the flow-volume loop in health and disease*

*The normal flow-volume curve is shown together with examples of how respiratory disease can alter the shape of the flow-volume loop:*

- a. flow volume loop from a healthy subject
- b. obstructive airway disease (e.g. asthma) before (solid line) and after (dashed line) the administration of a bronchodilator
- c. severe obstructive disease (e.g. emphysema) before (solid line) and after (dashed line) the administration of a bronchodilator
- d. restrictive lung disease (e.g. pulmonary fibrosis) – dashed line is predicted flow volume loop
- e. fixed major airflow obstruction (e.g. laryngeal obstruction) – dashed line is the predicted flow volume loop.



### **Spirometry Training**

Inadequate operator training will result in poor quality spirometry. To obtain clinically useful results the operator must comprehend the basic principals of high quality spirometry.

Anybody performing spirometry on patients must be:

- adequately trained in the performance of the correct breathing manoeuvre
- trained to identify and overcome poor technique
- trained to use, maintain and validate the spirometer correctly

- trained to identify whether the tests have been done properly and are consistent with previous results
- ideally, the quality of their testing should be regularly audited and feedback provided if the standard is low.

It is strongly recommended that staff performing spirometry attend a comprehensive spirometry training course. Some of these training courses are modular and allow flexibility in time and content to suit the range of different settings in which spirometry is measured. It is possible for the practice nurse to attend training on spirometry test performance while the doctor attends training on spirometry test interpretation.

### **Fitting Quality Spirometry into a Standard Consultation**

The following sequence is commonly employed:

- measure the patient's standing height (shoes removed)
- perform *pre-bronchodilator* spirometry as soon as you have determined that your patient requires the test
- administer a bronchodilator and then complete the rest of the consultation
- by the time you have done this, sufficient time will have passed for the *post-bronchodilator* spirometry to be done (i.e. 15 minutes)
- with the results of spirometry now available, you will be better equipped to discuss the diagnosis, outlook and agree on a management plan with your patient.

### **Suggested Further Reading**

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## SECTION 2

### SELECTING A SPIROMETER

#### **List of Currently Available Spirometers**

The spirometers currently available in Australia together with a summary of their features, specifications, manufacturer and primary Australian supplier are summarised in the following table. All the spirometers listed are reported to conform to the internationally accepted spirometry standards (ATS/ERS, 2005).

All information was supplied by the primary Australian distributor and was compiled in June 2011. The inclusion of a spirometer in the table does not imply endorsement by the authors. Most spirometers have additional features to those listed but may not have been included due to limited space.

#### **Factors to Consider When Purchasing a Spirometer**

- conformity to accepted spirometry performance standards
- ease of use
- provision of real-time graphic display of the manoeuvre (large enough to inspect)
- provision of immediate quality feedback concerning the acceptability of blows, including repeatability
- provision to interface with clinical software packages
- provision of customisable final spirometry report
- provision to print the final report
- price and cost of disposables
- reliability and ease of maintenance
- training, servicing and repair provided by supplier
- provision of a disposable sensor, barrier filter or easily cleaned/disinfected breathing circuit
- provision of appropriate normal reference values with lower limits of normal
- size and portability (if required)
- provision of a comprehensive operator's manual
- calibration/validation requirements.

#### **How to Use the Table**

Either browse the table or start by listing the features and specifications you require and then go to the table to determine which spirometer(s) provide these. It is strongly recommended that you *trial* the spirometer before buying to ensure that it meets *your* specific needs. An explanation of the features and specifications are given in the following table.

## Explanation of Features and Specifications Listed in Table

<b>Feature / Specification</b>	<b>Explanation</b>
Spirometer and manufacturer	Identifies each spirometer by name and gives manufacturer name
Primary Australian distributor	Name, address and contact phone number of the main supplier in Australia
<b>Hardware</b>	
Portable or desktop	Indicates whether or not the spirometer is designed as a portable system
Power supply	Describes the power source needed to operate the spirometer (e.g. batteries or mains power)
Sensor type	Describes the physical principle employed to measure flow/volume e.g. turbine, ultrasonic, bellows
Is external PC (not supplied) required	Indicates whether the spirometer needs a separate external computer (not supplied) to run a spirometry test
Internal or external (not supplied) printer	Indicates whether the spirometer is equipped with an internal printer or whether an external (not supplied) printer is required to print results
Weight (kg)	Total weight of spirometer in kilograms
Warranty period	Indicates time in years
<b>Costs</b>	
Cost of spirometer (ex GST)	Current retail price of the spirometer in Australia as at June 2011 – GST may be payable (does not include <i>external PC</i> or <i>external printer</i> )
Cost of disposables per patient (ex GST)	Estimated retail cost of consumables per patient (e.g. mouthpieces, other disposable items)
<b>Software</b>	
Patient storage capacity	Indicates how many individual patient results can be stored by the spirometer
Type of database	Indicates the type of database used
Interpretation software included	Indicates if the spirometer includes software for automatic clinical interpretation of the test results
Results download to clinical software	Indicates whether the test results (numeric and/or graphic) are potentially available for download to another database (e.g. Medical Director)
Provides feedback after each blow	Indicates whether feedback is provided to encourage maximum performance during the test
Provides grading of test quality	Indicates whether the spirometer grades the overall quality of pre and post-bronchodilator trials
<b>Reference Values</b>	
Reference values available	Indicates whether the operator can select from a number of normal reference studies and provides examples
Includes lower limit of normal	Indicates whether the statistically derived lower limit of normal (LLN) is printed on the final report (or used to provide the normal range) to facilitate interpretation of the measured value
Can add additional reference equations	Indicates whether the user can enter other reference equations
Can adjust for ethnicity	Indicates whether the reference values can be adjusted for ethnicity
Prints predicted flow-volume curve	Indicates whether the predicted flow-volume loop is printed on the report
<b>General Features</b>	
Indices measured	List of the <i>main</i> spirometric indices measured and printed/displayed by the spirometer (e.g. FEV <sub>1</sub> , FVC, FEV <sub>1</sub> /FVC, FEF <sub>25-75%</sub> , PEF)
Can user customise the final report	Indicates whether the user can customise the report (e.g. select which indices appear on the final report)
Meets 2005 ATS/ERS performance standard	Indicates whether the spirometer meets the 2005 ATS/ERS performance standards
Is printed report user definable	Indicates whether the user can customise the final printed report (e.g. user defined layout and select which indices appear)
Daily calibration check recommended	Indicates whether the manufacturer recommends that the spirometer requires its calibration to be adjusted or checked on a daily basis

Automatically adjusts calibration	Indicates whether the accuracy of the spirometer can be adjusted by the user after calibration, or whether the adjustment can only be carried out by the distributor
Curves displayed in real-time	Indicates whether a graphic display of the blow (e.g. flow-volume and/or volume-time curve) can be viewed as the subject performs the test
Prints volume-time / flow-volume curves	Indicates whether these curves can be printed
Provides serial report	Indicates whether the results from previous tests on a patient can be incorporated into the current report
Infection control precautions	Indicates recommended method to minimise the risk of patient cross-infection (e.g. disinfection, disposable sensor, barrier filter)
Report quantifies post-BD change	Indicates whether any change in spirometry values post-bronchodilator administration can be printed on the final report to facilitate interpretation of the significance of bronchodilator response
Supplied with user manual	Indicates whether the spirometer is supplied with a user manual
Training can be provided on purchase	Indicates whether the spirometer supplier can provide basic training on the use of the spirometer on purchase
<b><i>Other Key Features</i></b>	
Other key features	Describes other features or specifications considered important by the manufacturer

## Resource Respiratory Function Laboratories

The following Respiratory Function Laboratories have agreed to act as 'resource laboratories' for health professionals requiring advice on spirometers and the measurement of spirometry.

<b>New South Wales</b>		
Pulmonary Function Lab Sydney Children's Hospital (02) 93821475	Pulmonary Function Lab John Hunter Hospital (02) 4921 3470	Respiratory Function Lab Charles Sturt University (02) 6933 2059
<b>Queensland</b>		
Respiratory Function Lab Mater Children's Hospital (07) 38408146	Dept Respiratory Medicine Princess Alexandra Hospital (07) 3176 2046	Dept of Thoracic Medicine Royal Brisbane & Women's Hospital (07) 3636 7633
<b>South Australia</b>		
Respiratory Function Lab The Queen Elizabeth Hospital (08) 82226474	Lung Function Laboratory Royal Adelaide Hospital (08) 8222 5433	Lung Function Unit Repatriation General Hospital (08) 8275 1738
<b>Western Australia</b>		
Respiratory Function Lab Princess Margaret Hospital for Children (08) 9340 8990	Respiratory Function Lab Sir Charles Gairdner Hospital (08) 9346-3756	Dept Respiratory Medicine Royal Perth Hospital (08) 9224 2887
<b>Victoria</b>		
Respiratory Function Lab Austin Health (03) 9496 5739	Respiratory Function Lab Royal Melbourne Hospital (03) 9342 8491	Lung Function Laboratory The Alfred Hospital (03) 9076 3476
<b>Tasmania</b>		
Respiratory Function Unit Royal Hobart Hospital (03) 6222 7323	Respiratory Function Lab Launceston Hospital 0419 695 695	
<b>Australian Capital Territory</b>		
Pulmonary Function Lab The Canberra Hospital (02) 6244 2707		

**TABLE OF SPIROMETERS AVAILABLE IN AUSTRALIA**

	<b>Spirometer and manufacturer</b>	<b>Easy on-PC</b>	<b>EasyOne-line</b>	<b>EasyOne World Spirometer</b>	<b>Spiro Sonic</b>
		ndd Medical Technologies	ndd Medical Technologies	ndd Medical Technologies	Bird Healthcare
<b>Supplier</b>	Primary Australian distributor	Niche Medical PO Box 1737, North Sydney, NSW 2059 1300 136 855	Niche Medical PO Box 1737, North Sydney, NSW 2059 1300 136 855	Niche Medical PO Box 1737, North Sydney, NSW 2059 1300 136 855	Bird Healthcare 1/11 Sabre Drive, Melbourne, Victoria 1300 365 561
<b>Hardware</b>	Portable or desktop	Portable	Portable	Portable	Desk Top
	Power supply	PC powered	Two AA batteries	Two AA batteries	USB 5V
	Sensor type	Ultrasonic transit times	Ultrasonic transit times	Ultrasonic transit times	Ultrasonic
	Is external PC (not supplied) required	Yes	No	No	Yes
	Internal or external (not supplied) printer	External	External	External (supplied)	External
	Weight (kg)	0.16	0.25	0.25	0.15
Warranty period	One year	One year	One year	2 years	
<b>Costs</b>	Spirometer (ex GST)	\$2,300	\$3,400	\$3,400	\$999 - free with filter order
	Disposables per patient (ex GST)	Spirette @ \$3.20	Spirette @ \$3.20	Spirette @ \$3.20	\$2.35
<b>Software</b>	Patient storage capacity	Infinite with PC	700, infinite with PC	700, infinite with PC	Infinite with PC
	Type of database	MS Access™	MS Access™	MS Access™	Multiple
	Interpretation software included	Yes	Yes	Yes	Yes
	Results download to clinical software	Yes	Yes	Yes	Yes
	Provides feedback after each blow	Yes	Yes	Yes	Yes
Provides grading of test quality	Yes	Yes	Yes	Yes	
<b>Reference Values</b>	Reference values available	NHANES III, Knudson, Stanojevic, + others	NHANES III, Knudson, Stanojevic, + others	NHANES III, Knudson, Stanojevic, + others	Knudson, NHANES III, ECCS, + others
	Includes lower limit of normal	Yes	Yes	Yes	Yes
	Can add additional reference equations	No	No	No	Yes
	Can adjust for ethnicity	Yes	Yes	Yes	Yes
	Prints predicted flow-volume curve	Yes	No	No	Yes
<b>General Features</b>	Indices measured	FEV <sub>1</sub> , FVC, FEV <sub>1</sub> /FVC, PEF, FEF <sub>25-75%</sub> , + others	FEV <sub>1</sub> , FVC, FEV <sub>1</sub> /FVC, PEF, FEF <sub>25-75%</sub> , + others	FEV <sub>1</sub> , FVC, FEV <sub>1</sub> /FVC, PEF, FEF <sub>25-75%</sub> , + others	FEV <sub>1</sub> , FVC, FEV <sub>1</sub> /FVC, PEF, FEF <sub>25-75%</sub> , + others
	Can user customise the final report	Yes	Yes	Yes	Yes
	Meets 2005 ATS/ERS performance std	Yes	Yes	Yes	Yes
	Is printed report user definable	Yes	Yes	Yes	Yes
	Daily calibration check recommended	No	No	No	No
	Automatically adjusts calibration	No, guaranteed lifetime stability	No, guaranteed lifetime stability	No, guaranteed lifetime stability	No
	Curves displayed in real-time	Yes	Yes	No	Yes
	Prints volume-time / flow-volume curves	Yes, both	Yes, both	Yes, both	Yes, both
	Provides serial report	Yes	Yes	Yes	Yes
	Infection control precautions	Disposable spirette	Disposable spirette	Disposable spirette	Internal UV light + filter = whole unit can be solution sterilized
	Report quantifies post-BD changes	Yes	Yes	Yes	Yes
Supplied with user manual	Yes	Yes	Yes	Yes	
Training can be provided on purchase	Yes	Yes	Yes	Yes	
<b>Extra</b>	Other key features	No calibration needed; maintenance free; easy to use; ideal for use in general practice, hospital laboratories and research	No calibration needed; maintenance free; easy to use; ideal for use in general practice, hospital laboratories and research	No calibration needed; maintenance free; easy to use; ideal for use in general practice, hospital laboratories and research	Many. custom fit to the most effective bacterial filter - Suregard.

Table of spirometers available in Australia (cont.)

	Spirometer and manufacturer	Spiro Sonic +	Spirolab III	Minispir	Spirodoc
		Bird Healthcare	MIR	MIR	MIR
Supplier	Primary Australian distributor	Bird Healthcare 1/11 Sabre Drive, Melbourne, Victoria 1300 365 561	Zone Medical 7/22 Mavis Court, Yatala, Qld 4207 (07) 3808 0999	Zone Medical 7/22 Mavis Court, Yatala, Qld 4207 (07) 3808 0999	Zone Medical 7/22 Mavis Court, Yatala, Qld 4207 (07) 3808 0999
Hardware	Portable or desktop	Portable	Portable	PC based	Portable and PC based
	Power supply	Battery or mains power	Battery or mains power	USB powered	Rechargeable battery
	Sensor type	Ultrasonic	Turbine	Turbine	Turbine
	Is external PC (not supplied) required	No	No	Yes	No
	Internal or external (not supplied) printer	External	Internal	External	External
	Weight (kg)	0.3	1.90	0.07	0.11
	Warranty period	2 years	One year	One year	One year
Costs	Spirometer (ex GST)	\$795 - free with filter order	\$2,995	\$1,495	\$1,995
	Disposables per patient (ex GST)	\$2.35	Disposable turbine and mouthpiece @ \$1.49	Disposable turbine and mouthpiece @ \$1.49	Disposable turbine and mouthpiece @ \$1.49
Software	Patient storage capacity	10,000	6,000	Infinite with PC	10,000
	Type of database	Multiple	MS Access™	MS Access™	MS Access™
	Interpretation software included	Yes	Yes	Yes	Yes
	Results download to clinical software	Yes	Yes	Yes	Yes
	Provides feedback after each blow	Yes	Yes	Yes	Yes
	Provides grading of test quality	Yes	Yes	Yes	Yes
Reference Values	Reference values available	Knudson, NHANES III, ECCS, + others	NHANES III, Knudson, ECCS, + others	NHANES III, Knudson, ECCS, + others	NHANES III, Knudson, ECCS, + others
	Includes lower limit of normal	Yes	No	No	No
	Can add additional reference equations	Yes	Can be added by supplier	Can be added by supplier	Can be added by supplier
	Can adjust for ethnicity	Yes	Yes	Yes	Yes
	Prints predicted flow-volume curve	Yes	Yes	Yes	Yes
General Features	Indices measured	FEV <sub>1</sub> , FVC, FEV <sub>1</sub> /FVC, PEF, FEF <sub>25-75%</sub> , + others	FEV <sub>1</sub> , FVC, FEV <sub>1</sub> /FVC, PEF, FEF <sub>25-75%</sub> , + others	FEV <sub>1</sub> , FVC, FEV <sub>1</sub> /FVC, PEF, FEF <sub>25-75%</sub> , + others	FEV <sub>1</sub> , FVC, FEV <sub>1</sub> /FVC, PEF, FEF <sub>25-75%</sub> , + others
	Can user customise the final report	Yes	Yes	Yes	Yes
	Meets 2005 ATS/ERS performance standard	Yes	Yes	Yes	Yes
	Is printed report user definable	Yes	Yes	Yes	Yes
	Daily calibration check recommended	No	No, uses pre-calibrated disposable turbine	No, uses pre-calibrated disposable turbine	No, uses pre-calibrated disposable turbine
	Automatically adjusts calibration	No	No	No	No
	Curves displayed in real-time	Yes	Yes	Yes	Yes
	Prints volume-time / flow-volume curves	Yes, both	Yes	Yes	Yes
	Provides serial report	Yes	Yes	Yes	Yes
	Infection control precautions	Internal UV light + filter	Disposable turbine and mouthpiece	Disposable turbine and mouthpiece	Disposable turbine and mouthpiece
	Report quantifies post-BD changes	Yes	Yes	Yes	Yes
	Supplied with user manual	Yes + in-built prompting	Yes	Yes	Yes
Training can be provided on purchase	Yes	Yes	Yes	Yes	
Extra	Other key features	LCD Screen; Blue tooth to PC or mobile phone for additional flow-volume loop screen; custom fit to the most effective bacterial filter - Suregard.	Automatic BTPS correction; alphanumeric keyboard, colour display, optional SpO <sub>2</sub> ; stand alone or PC	Automatic BTPS correction; PC based; optional SpO <sub>2</sub> ; PC software included	Automatic BTPS correction; optional SpO <sub>2</sub> ; 3 axial accelerometer for 6MWT and sleep evaluation; telemedicine ready

Table of spirometers available in Australia (cont.)

	Spirometer and manufacturer	Spirobank II	Spirobank G USB	Spirobank USB	Spirotel
		MIR	MIR	MIR	MIR
Supplier	Primary Australian distributor	Zone Medical 7/22 Mavis Court, Yatala, Qld 4207 (07) 3808 0999	Zone Medical 7/22 Mavis Court, Yatala, Qld 4207 (07) 3808 0999	Zone Medical 7/22 Mavis Court, Yatala, Qld 4207 (07) 3808 0999	Zone Medical 7/22 Mavis Court, Yatala, Qld 4207 (07) 3808 0999
Hardware	Portable or desktop	Portable and PC based	Portable and PC based	Portable and PC based	Portable and PC based
	Power supply	Battery	Battery	Battery	Battery
	Sensor type	Turbine	Turbine	Turbine	Turbine
	Is external PC (not supplied) required	No	No	No	Yes
	Internal or external (not supplied) printer	External	External	External	External
	Weight (kg)	0.18	0.18	0.18	0.10
	Warranty period	One year	One year	One year	One year
Costs	Spirometer (ex GST)	\$1,795	\$1,795	\$995	\$1,495
	Disposables per patient (ex GST)	Disposable turbine and mouthpiece @ \$1.49	Disposable turbine and mouthpiece @ \$1.49	Disposable turbine and mouthpiece @ \$1.49	Disposable turbine and mouthpiece @ \$1.49
Software	Patient storage capacity	6,000	6,000	One	800
	Type of database	MS Access™	MS Access™	MS Access™	MS Access™
	Interpretation software included	Yes	Yes	Yes	Yes
	Results download to clinical software	Yes	Yes	Yes	Yes
	Provides feedback after each blow	Yes	Yes	Yes	Yes
	Provides grading of test quality	Yes	Yes	Yes	Yes
Reference Values	Reference values available	NHANES III, Knudson, ECCS, + others	NHANES III, Knudson, ECCS, + others	NHANES III, Knudson, ECCS, + others	NHANES III, Knudson, ECCS, + others
	Includes lower limit of normal	No	No	No	No
	Can add additional reference equations	Can be added by supplier	Can be added by supplier	Can be added by supplier	Can be added by supplier
	Can adjust for ethnicity	Yes	Yes	Yes	Yes
	Prints predicted flow-volume curve	Yes	Yes	Yes	Yes
General Features	Indices measured	FEV <sub>1</sub> , FVC, FEV <sub>1</sub> /FVC, PEF, FEF <sub>25-75%</sub> , + others	FEV <sub>1</sub> , FVC, FEV <sub>1</sub> /FVC, PEF, FEF <sub>25-75%</sub> , + others	FEV <sub>1</sub> , FVC, FEV <sub>1</sub> /FVC, PEF, FEF <sub>25-75%</sub> , + others	FEV <sub>1</sub> , FVC, FEV <sub>1</sub> /FVC, PEF, FEF <sub>25-75%</sub> , + others
	Can user customise the final report	Yes	Yes	Yes	Yes
	Meets 2005 ATS/ERS performance standard	Yes	Yes	Yes	Yes
	Is printed report user definable	Yes	Yes	Yes	Yes
	Daily calibration check recommended	No, uses pre-calibrated disposable turbine	No, uses pre-calibrated disposable turbine	No, uses pre-calibrated disposable turbine	No, uses pre-calibrated disposable turbine
	Automatically adjusts calibration	No	No	No	No
	Curves displayed in real-time	Yes	Yes	Yes	Yes
	Prints volume-time / flow-volume curves	Yes	Yes	Yes	Yes
	Provides serial report	Yes	Yes	Yes	Yes
	Infection control precautions	Disposable turbine and mouthpiece	Disposable turbine and mouthpiece	Disposable turbine and mouthpiece	Disposable turbine and mouthpiece
	Report quantifies post-BD changes	Yes	Yes	Yes	Yes
	Supplied with user manual	Yes	Yes	Yes	Yes
Training can be provided on purchase	Yes	Yes	Yes	Yes	
Extra	Other key features	Patient data, short, long term (overnight) with desaturation event recording and sleep apnoea detection and 6 MWT; Bluetooth and USB	Automatic BTPS correction; built in Bluetooth, USB and RS232 connection to PC; PC software included	Automatic BTPS correction; PC software included	Built in modem for transmission of Home Care results, spot and overnight measurements; automatic BTPS correction

Table of spirometers available in Australia (cont.)

	Spirometer and manufacturer	Micro Quark	Spiropalm	Spiropalm +	Pony FX
		Cosmed	Cosmed	Cosmed	Cosmed
Supplier	Primary Australian distributor	JLM Accuthek Health Care Unit 44, 11-21 Underwood Rd, Homebush, NSW 2140 1300 793 755	JLM Accuthek Health Care Unit 44, 11-21 Underwood Rd, Homebush, NSW 2140 1300 793 755	JLM Accuthek Health Care Unit 44, 11-21 Underwood Rd, Homebush, NSW 2140 1300 793 755	JLM Accuthek Health Care Unit 44, 11-21 Underwood Rd, Homebush, NSW 2140 1300 793 755
Hardware	Portable or desktop	USB	Portable	Portable	Desktop
	Power supply	USB	Rechargeable battery and charger	Rechargeable battery and charger	Rechargeable battery and charger
	Sensor type	Turbine	Turbine	Disposable Lilly pneumotach	Turbine
	Is external PC (not supplied) required	PC required	Stand alone or PC	Stand alone or PC	Stand alone or PC
	Internal or external (not supplied) printer	External via PC	External or PC printer	External or PC printer	Internal or PC printer
	Weight (kg)	0.08	0.39	0.33	1.20
	Warranty period	18 months	18 months	18 months	18 months
Costs	Spirometer (ex GST)	\$1,795	\$2,395	\$2,395	\$2,990
	Disposables per patient (ex GST)	Filter @ \$1.75	Filter @ \$1.75	Flowsafe pneumotach @ \$3.90	Filter @ \$1.75
Software	Patient storage capacity	Infinite	1,000, infinite with PC	1,000, infinite with PC	600, infinite with PC
	Type of database	Cosmed	Cosmed	Cosmed	Cosmed
	Interpretation software included	Yes	Yes	Yes	Yes
	Results download to clinical software	Yes, fully MD3 compatible	Yes, fully MD3 compatible	Yes, fully MD3 compatible	Yes, fully MD3 compatible
	Provides feedback after each blow	Yes, to ATS/ERS guidelines	Yes, to ATS/ERS guidelines	Yes, to ATS/ERS guidelines	Yes, to ATS/ERS guidelines
Provides grading of test quality	Yes	Yes	Yes	Yes	
Reference Values	Reference values available	NHANES III, Knudson 83, ECCS, + others	NHANES III, Knudson 83, ECCS, + others	NHANES III, Knudson 83, ECCS, + others	NHANES III, Knudson 83, ECCS, + others
	Includes lower limit of normal	Yes	Yes	Yes	Yes
	Can add additional reference equations	Yes	Yes	Yes	Yes
	Can adjust for ethnicity	Yes	Yes	Yes	Yes
Prints predicted flow-volume curve	Yes	Yes	Yes	Yes	
General Features	Indices measured	FEV <sub>1</sub> , FVC, FEV <sub>1</sub> /FVC, PEF, FEF <sub>25-75%</sub> , + others	FEV <sub>1</sub> , FVC, FEV <sub>1</sub> /FVC, PEF, FEF <sub>25-75%</sub> , + others	FEV <sub>1</sub> , FVC, FEV <sub>1</sub> /FVC, PEF, FEF <sub>25-75%</sub> , + others	FEV <sub>1</sub> , FVC, FEV <sub>1</sub> /FVC, PEF, FEF <sub>25-75%</sub> , + others
	Can user customise the final report	Yes	Yes	Yes	Yes
	Meets 2005 ATS/ERS performance standard	Yes	Yes	Yes	Yes
	Is printed report user definable	Yes	Yes	Yes	Yes
	Daily calibration check recommended	No	No	No	No
	Automatically adjusts calibration	Yes	Yes	Yes	Yes
	Curves displayed in real-time	Yes	Yes	Yes	Yes
	Prints volume-time / flow-volume curves	Yes	Yes	Yes	Yes
	Provides serial report	Yes	Yes	Yes	Yes
	Infection control precautions	Filter	Filter	Filter	Filter
	Report quantifies post-BD changes	Yes	Yes	Yes	Yes
Supplied with user manual	User manual on CD	User manual on CD	User manual on CD	User manual on CD	
Training can be provided on purchase	Yes	Yes	Yes	Yes	
Extra	Other key features	USB Spirometer; includes Cosmed FT software, an easy to use but fully configurable RFT testing platform; small and reliable	Simple operation; optional oximetry module; optional 6MWT with full ventilation, HR and SpO <sub>2</sub> ; USB connection for printer and PC	Simple operation; optional oximetry module; USB connection for printer and PC	Integrated colour screen and printer; optional oximeter; optional airways resistance; paediatric incentives; bronchial challenge testing

Table of spirometers available in Australia (cont.)

	Spirometer and manufacturer	Pony Fx Flowsafe	Micro w/Reports Software	Pneumotrac w/Spirotrac Software	Alpha w/Reports Software
		Cosmed	Vitalograph	Vitalograph	Vitalograph
Supplier	Primary Australian distributor	JLM Accutek Health Care Unit 44, 11-21 Underwood Rd, Homebush, NSW 2140 1300 793 755	Ecomed Trading Pty Ltd U4/30 Foundry Road, Seven Hills, NSW 2147 1800 67 5432	Ecomed Trading Pty Ltd U4/30 Foundry Road, Seven Hills, NSW 2147 1800 67 5432	Ecomed Trading Pty Ltd U4/30 Foundry Road, Seven Hills, NSW 2147 1800 67 5432
Hardware	Portable or desktop	Desktop	Hand-held	Desktop	Desktop
	Power supply	Rechargeable battery and charger	Battery	USB power from PC	Battery or mains power
	Sensor type	Disposable Lilly pneumotach	Fleisch pneumotach	Fleisch pneumotach	Fleisch pneumotach
	Is external PC (not supplied) required	Stand alone PC	No	Yes	No
	Internal or external (not supplied) printer	Internal or PC printer	Sends PDF to PC	Print via PC	Internal or send PDF to PC
	Weight (kg)	1.20	0.17	0.58	2.00
	Warranty period	18 months	One year	One year	One year
Costs	Spirometer (ex GST)	\$2,990	\$1,250	\$2,495	\$2,595
	Disposables per patient (ex GST)	Flowsafe pneumotach @ \$3.90	Mouthpiece @ \$0.28 or one-way m/piece @ \$0.82	Mouthpiece @ \$0.28 or one-way m/piece @ \$0.82	Mouthpiece @ \$0.28 or one-way m/piece @ \$0.82
Software	Patient storage capacity	600, infinite with PC	Nil	Infinite	9
	Type of database	Cosmed	PDF file	MS SQL	PDF file
	Interpretation software included	Yes	Yes	Yes	Yes
	Results download to clinical software	Yes, fully MD3 compatible	No	Yes	No
	Provides feedback after each blow	Yes, to ATS/ERS guidelines	Yes	Yes	Yes
Provides grading of test quality	Yes	Yes	Yes	Yes	
Reference Values	Reference values available	NHANES III, Knudson 83, ECCS, + others	ERS'93	NHANES III, ERS'93, Gore, + others	Gore, ERS'93, Polgar, +others
	Includes lower limit of normal	Yes	No	Yes	Yes
	Can add additional reference equations	Yes	No	No	No
	Can adjust for ethnicity	Yes	Yes	Yes	Yes
Prints predicted flow-volume curve	Yes	Yes	Yes	Yes	
General Features	Indices measured	FEV <sub>1</sub> , FVC, FEV <sub>1</sub> /FVC, PEF, FEF <sub>25-75%</sub> , + others	FEV <sub>1</sub> , FVC, FEV <sub>1</sub> /FVC, PEF, FEF <sub>25-75%</sub> + others	FEV <sub>1</sub> , FVC, FEV <sub>1</sub> /FVC, PEF, FEF <sub>25-75%</sub> + others	FEV <sub>1</sub> , FVC, FEV <sub>1</sub> /FVC, PEF, FEF <sub>25-75%</sub> + others
	Can user customise the final report	Yes	No	Yes	No
	Meets 2005 ATS/ERS performance standard	Yes	Yes	Yes	Yes
	Is printed report user definable	Yes	No	Yes	Yes
	Daily calibration check recommended	No	No	No	No
	Automatically adjusts calibration	Yes	Yes	Yes	Yes
	Curves displayed in real-time	Yes	No	Yes	Yes
	Prints volume-time / flow-volume curves	Yes	Yes, both	Yes, both	Yes, both
	Provides serial report	Yes	Yes	Yes	Yes
	Infection control precautions	Disposable pneumotach	Disposable one-way mouthpiece	Disposable one-way mouthpiece	Disposable one-way mouthpiece
	Report quantifies post-BD changes	Yes	No	Yes	Yes
Supplied with user manual	User manual on CD	Yes	Yes	Yes	
Training can be provided on purchase	Yes	Yes	Yes	Yes	
Extra	Other key features	Integrated colour screen and printer; optional oximeter; optional airways resistance; paediatric incentives; bronchial challenge testing	Small and portable	Full Spirotrac spirometry software	Quick and easy to use

Table of spirometers available in Australia (cont.)

	Spirometer and manufacturer	Alpha Touch w/Reports Software	Alpha Touch w/Spirotrac Software	In2itive w/Reports Software	In2itive w/Spirotrac Software
		Vitalograph	Vitalograph	Vitalograph	Vitalograph
Supplier	Primary Australian distributor	Ecomed Trading Pty Ltd U4/30 Foundry Road, Seven Hills, NSW 2147 1800 67 5432	Ecomed Trading Pty Ltd U4/30 Foundry Road, Seven Hills, NSW 2147 1800 67 5432	Ecomed Trading Pty Ltd U4/30 Foundry Road, Seven Hills, NSW 2147 1800 67 5432	Ecomed Trading Pty Ltd U4/30 Foundry Road, Seven Hills, NSW 2147 1800 67 5432
Hardware	Portable or desktop	Desktop	Desktop	Hand-held	Hand-held
	Power supply	Battery or mains power	Battery or mains power	Battery	Battery
	Sensor type	Fleisch pneumotach	Fleisch pneumotach	Fleisch pneumotach	Fleisch pneumotach
	Is external PC (not supplied) required	No	No	No	No
	Internal or external (not supplied) printer	Internal and send PDF to PC	Internal and send PDF to PC	External or send to PC	External or send to PC
	Weight (kg)	2.00	2.00	0.23	0.23
Warranty period	One year	One year	One year	One year	
Costs	Spirometer (ex GST)	\$3,297	\$3,495	\$2,997	\$3,495
	Disposables per patient (ex GST)	Mouthpiece @ \$0.28 or one-way m/piece @ \$0.82	Mouthpiece @ \$0.28 or one-way m/piece @ \$0.82	Mouthpiece @ \$0.28 or one-way m/piece @ \$0.82	Mouthpiece @ \$0.28 or one-way m/piece @ \$0.82
Software	Patient storage capacity	10,000+, infinite with PC	10,000+, infinite with PC	10,000+, infinite with PC	10,000+, infinite with PC
	Type of database	PDF file	MS SQL	PDF file	MS SQL
	Interpretation software included	Yes	Yes	Yes	Yes
	Results download to clinical software	No	Yes	No	Yes
	Provides feedback after each blow	Yes	Yes	Yes	Yes
	Provides grading of test quality	Yes	Yes	Yes	Yes
Reference Values	Reference values available	NHANES III, ERS'93, Gore, + others	NHANES III, ERS'93, Gore, + others	NHANES III, ERS'93, Gore, + others	NHANES III, ERS'93, Gore, + others
	Includes lower limit of normal	Yes	Yes	Yes	Yes
	Can add additional reference equations	No	No	No	No
	Can adjust for ethnicity	Yes	Yes	Yes	Yes
	Prints predicted flow-volume curve	Yes	Yes	Yes	Yes
General Features	Indices measured	FEV <sub>1</sub> , FVC, FEV <sub>1</sub> /FVC, PEF, FEF <sub>25-75%</sub> + others	FEV <sub>1</sub> , FVC, FEV <sub>1</sub> /FVC, PEF, FEF <sub>25-75%</sub> + others	FEV <sub>1</sub> , FVC, FEV <sub>1</sub> /FVC, PEF, FEF <sub>25-75%</sub> + others	FEV <sub>1</sub> , FVC, FEV <sub>1</sub> /FVC, PEF, FEF <sub>25-75%</sub> + others
	Can user customise the final report	Yes	Yes	Yes	Yes
	Meets 2005 ATS/ERS performance standard	Yes	Yes	Yes	Yes
	Is printed report user definable	Yes	Yes	Yes	Yes
	Daily calibration check recommended	No	No	No	No
	Automatically adjusts calibration	Yes	Yes	Yes	Yes
	Curves displayed in real-time	Yes	Yes	Yes	Yes
	Prints volume-time / flow-volume curves	Yes, both	Yes, both	Yes, both	Yes, both
	Provides serial report	Yes	Yes	Yes	Yes
	Infection control precautions	Disposable one-way mouthpiece	Disposable one-way mouthpiece	Disposable one-way mouthpiece	Disposable one-way mouthpiece
	Report quantifies post-BD changes	Yes	Yes	Yes	Yes
	Supplied with user manual	Yes	Yes	Yes	Yes
Training can be provided on purchase	Yes	Yes	Yes	Yes	
Extra	Other key features	Bright touch screen; portability, printing and PC connectivity	Bright touch screen; portability, printing and PC connectivity	Bright touch screen; portability, printing and PC connectivity	Bright touch screen; portability, printing and PC connectivity

Table of spirometers available in Australia (cont.)

	Spirometer and manufacturer	Compact	Gold Standard	Gold Standard Plus	BlueSpiro
		Vitalograph	Vitalograph	Vitalograph	Medisoft
Supplier	Primary Australian distributor	Ecomed Trading Pty Ltd U4/30 Foundry Road, Seven Hills, NSW 2147 1800 67 5432	Ecomed Trading Pty Ltd U4/30 Foundry Road, Seven Hills, NSW 2147 1800 67 5432	Ecomed Trading Pty Ltd U4/30 Foundry Road, Seven Hills, NSW 2147 1800 67 5432	Ascencia Pty Ltd 28 Waverley Park Dve, Mulgrave, VIC 3170 1 300 887619
Hardware	Portable or desktop	Desktop	Desktop	Desktop	Portable and wireless
	Power supply	Mains power	Mains power	Mains power	Rechargeable battery
	Sensor type	Fleisch pneumotach	Volume displacement	Volume displacement	Lilly pneumotach
	Is external PC (not supplied) required	No	No	No	Yes
	Internal or external (not supplied) printer	Internal or send PDF to PC	Graph paper	Graph paper + external	PC printer
	Weight (kg)	2.26	8.70	9.10	0.34 (without battery)
Warranty period	One year	One year	One year	One year	
Costs	Spirometer (ex GST)	\$4,997	\$5,495	\$8,995	\$2,888
	Disposables per patient (ex GST)	Mouthpiece @ \$0.28 or one-way m/piece @ \$0.82	Mouthpiece @ \$0.28 or one-way m/piece @ \$0.82	Mouthpiece @ \$0.28 or one-way m/piece @ \$0.82	Filter @ \$1.96
Software	Patient storage capacity	2,000	Nil	160	Infinite
	Type of database	Internal flash	n/a	n/a	SQL
	Interpretation software included	Yes	No	Yes	Yes
	Results download to clinical software	No	No	No	Yes
	Provides feedback after each blow	Yes	No	No	Yes
	Provides grading of test quality	Yes	No	Yes	Yes
Reference Values	Reference values available	NHANES III, ERS'93, + others	Manual tables used	NHANES III, ERS'93, + others	Stanojevic, NHANES III, Knudson, + others
	Includes lower limit of normal	Yes	n/a	No	Yes
	Can add additional reference equations	No	n/a	No	Yes
	Can adjust for ethnicity	Yes	n/a	Yes	Yes
	Prints predicted flow-volume curve	Yes	No	Yes	Yes
General Features	Indices measured	FEV <sub>1</sub> , FVC, FEV <sub>1</sub> /FVC, PEF, FEF <sub>25-75%</sub> + others	FEV <sub>1</sub> , FVC, FEV <sub>1</sub> /FVC, + others	FEV <sub>1</sub> , FVC, FEV <sub>1</sub> /FVC, PEF, FEF <sub>25-75%</sub> + others	FEV <sub>1</sub> , FVC, FEV <sub>1</sub> /FVC, PEF, FEF <sub>25-75%</sub> , + others
	Can user customise the final report	Yes	No	No	Yes
	Meets 2005 ATS/ERS performance standard	Yes	Yes	Yes	Yes
	Is printed report user definable	Yes	No	No	Yes
	Daily calibration check recommended	No	No	No	Monthly
	Automatically adjusts calibration	Yes	No	No	Yes
	Curves displayed in real-time	Yes	Yes	Yes	Yes
	Prints volume-time / flow-volume curves	Yes, both	Vol-time	Vol-time	Yes, both
	Provides serial report	Yes	No	No	Yes
	Infection control precautions	Disposable one-way mouthpiece	Disposable one-way mouthpiece	Disposable one-way mouthpiece	Disposable filter or any cold sterilisation liquid
	Report quantifies post-BD changes	Yes	Yes	Yes	Yes
	Supplied with user manual	Yes	Yes	Yes	Yes
Training can be provided on purchase	Yes	Yes	Yes	Yes	
Extra	Other key features	Large bright touch screen	Instant volume-time curve on graph paper	Instant volume-time curve on graph paper	BlueTooth (wireless); challenge, EIA and MVV tests with dose response curve

Table of spirometers available in Australia (cont.)

	Spirometer and manufacturer	Micro 6000	Micro 6000 - Heated	CPFS/D	Microlab Mk8
		Medisoft	Medisoft	MedGraphics	CareFusion
Supplier	Primary Australian distributor	Ascencia Pty Ltd 28 Waverley Park Dve, Mulgrave, VIC 3170 1 300 887619	Ascencia Pty Ltd 28 Waverley Park Dve, Mulgrave, VIC 3170 1 300 887619	Mortara Instrument Unit 28 / 9 Hoyle Ave, Castle Hill, NSW 2154 02 8070 9303	CareFusion Australia 3/167 Prospect Hwy, Seven Hills, NSW 2147 1800 110 511
Hardware	Portable or desktop	Portable	Desktop	Portable	Portable
	Power supply	USB powered	USB powered	Both via PC battery	Battery or mains power
	Sensor type	Lilly pneumotach	Heated Lilly pneumotach	Patented bi-directional Pitot tube flow sensor	Turbine
	Is external PC (not supplied) required	Yes	Yes	Yes	No
	Internal or external (not supplied) printer	PC printer	PC printer	No	Internal
	Weight (kg)	0.34 (including handle)	1.90	0.56	0.63
	Warranty period	One year	One year	One year	18 months
Costs	Spirometer (ex GST)	\$2,968	\$3,774	\$2,795	\$3,100
	Disposables per patient (ex GST)	Filter @ \$1.96	Filter @ \$1.96	Sterilising solution or filter	Filter @ \$2.00
Software	Patient storage capacity	Infinite	Infinite	Unlimited	2,000, infinite with PC
	Type of database	SQL	SQL	MS SQL	MS Access™
	Interpretation software included	Yes	Yes	Yes	Yes
	Results download to clinical software	Yes	Yes	Yes	Yes
	Provides feedback after each blow	Yes	Yes	Yes	Yes
	Provides grading of test quality	Yes	Yes	Yes	Yes
Reference Values	Reference values available	Stanojevic, NHANES III, Knudson, + others	Stanojevic, NHANES III, Knudson, + others	Knudson, NHANES III, ECCS, +others	Knudson, NHANES III, ECCS, +others
	Includes lower limit of normal	Yes	Yes	Yes	Yes
	Can add additional reference equations	Yes	Yes	Yes	No
	Can adjust for ethnicity	Yes	Yes	Yes	Yes
	Prints predicted flow-volume curve	Yes	Yes	Yes	Yes
General Features	Indices measured	FEV <sub>1</sub> , FVC, FEV <sub>1</sub> /FVC, PEF, FEF <sub>25-75%</sub> , + others	FEV <sub>1</sub> , FVC, FEV <sub>1</sub> /FVC, PEF, FEF <sub>25-75%</sub> , + others	FEV <sub>1</sub> , FVC, FEV <sub>1</sub> /FVC, PEF, FEF <sub>25-75%</sub> , + others	FEV <sub>1</sub> , FVC, FEV <sub>1</sub> /FVC, PEF, FEF <sub>25-75%</sub> , + others
	Can user customise the final report	Yes	Yes	Yes	Yes
	Meets 2005 ATS/ERS performance standard	Yes	Yes	Yes	Yes
	Is printed report user definable	Yes	Yes	Yes	Yes
	Daily calibration check recommended	Monthly	Monthly	Yes	No
	Automatically adjusts calibration	Yes	Yes	Yes	No
	Curves displayed in real-time	Yes	Yes	Yes	Yes
	Prints volume-time / flow-volume curves	Yes, both	Yes, both	Yes, both	Yes, both
	Provides serial report	Yes	Yes	Yes	Yes
	Infection control precautions	Disposable filter or any cold sterilisation liquid	Disposable filter or any cold sterilisation liquid	Disposable filter or cleaning of pneumotach	Disposable filter
	Report quantifies post-BD changes	Yes	Yes	Yes	Yes
	Supplied with user manual	Yes	Yes	Yes	Yes
	Training can be provided on purchase	Yes	Yes	Yes	Yes
Extra	Other key features	Challenge and EIA tests with dose response curve; MVV test	Full weather station (auto BTPS correction); challenge, EIA and MVV tests	Powerful and versatile; BreezeSuite software simplifies patient testing	Colour touch screen; USB port

Table of spirometers available in Australia (cont.)

	Spirometer and manufacturer	Microloop Mk8	Spiro USB	Micro Plus	Micro GP
		CareFusion	CareFusion	CareFusion	CareFusion
Supplier	Primary Australian distributor	CareFusion Australia 3/167 Prospect Hwy, Seven Hills, NSW 2147 1800 110 511	CareFusion Australia 3/167 Prospect Hwy, Seven Hills, NSW 2147 1800 110 511	CareFusion Australia 3/167 Prospect Hwy, Seven Hills, NSW 2147 1800 110 511	CareFusion Australia 3/167 Prospect Hwy, Seven Hills, NSW 2147 1800 110 511
Hardware	Portable or desktop	Portable	Desktop	Portable	Portable
	Power supply	Battery or mains power	USB	9V battery	9V battery
	Sensor type	Turbine	Turbine	Turbine	Turbine
	Is external PC (not supplied) required	No	Yes	No	No
	Internal or external (not supplied) printer	External	External	External	External
	Weight (kg)	0.19	0.13	0.19	0.19
	Warranty period	18months	18 months	18 months	18 months
Costs	Spirometer (ex GST)	\$2,195	\$1,995	\$950	\$1,350
	Disposables per patient (ex GST)	Filter @ \$2.00	Filter @ \$2.00	Mouthpiece @ \$0.25	Mouthpiece @ \$0.25
Software	Patient storage capacity	2,000, infinite with PC	Infinite	Nil, infinite with PC	Nil, infinite with PC
	Type of database	MS Access™	MS Access™	MS Access™	MS Access™
	Interpretation software included	Yes	Yes	No	No
	Results download to clinical software	Yes	Yes	Yes	Yes
	Provides feedback after each blow	Yes	Yes	Yes	Yes
	Provides grading of test quality	Yes	Yes	Yes	Yes
Reference Values	Reference values available	Knudson, NHANES III, ECCS, +others	Knudson, NHANES III, ECCS, +others	No, software required	No, software required
	Includes lower limit of normal	Yes	Yes	No	No
	Can add additional reference equations	No	No	No	No
	Can adjust for ethnicity	Yes	Yes	No	No
	Prints predicted flow-volume curve	Yes	Yes	Yes, with software	Yes, with software
General Features	Indices measured	FEV <sub>1</sub> , FVC, FEV <sub>1</sub> /FVC, PEF, FEF <sub>25-75%</sub> , + others	FEV <sub>1</sub> , FVC, FEV <sub>1</sub> /FVC, PEF, FEF <sub>25-75%</sub> , + others	FEV <sub>1</sub> , FVC, FEV <sub>1</sub> /FVC, PEF, FEV <sub>6</sub>	FEV <sub>1</sub> , FVC, FEV <sub>1</sub> /FVC, PEF, FEV <sub>6</sub>
	Can user customise the final report	Yes	Yes	Yes	Yes
	Meets 2005 ATS/ERS performance standard	Yes	Yes	Yes	Yes
	Is printed report user definable	Yes	Yes	Yes	Yes
	Daily calibration check recommended	No	No	No	No
	Automatically adjusts calibration	No	No	No	No
	Curves displayed in real-time	Yes	Yes	No	No
	Prints volume-time / flow-volume curves	Yes, both	Yes, both	Yes, both	Yes, both
	Provides serial report	Yes	No	Yes	Yes
	Infection control precautions	Disposable filter	Disposable filter	Disposable filter	Disposable filter
	Report quantifies post-BD changes	Yes	Yes	Yes	Yes
	Supplied with user manual	Yes	Yes	Yes	Yes
	Training can be provided on purchase	Yes	Yes	Yes	Yes
Extra	Other key features	Colour touch screen; USB port	Simple USB connection	Cost effective simplicity	Cost effective simplicity

Table of spirometers available in Australia (cont.)

	Spirometer and manufacturer	MicroDL	Spiropro	Masterscreen Pneumo TP	Masterscreen Pneumo Heated TP
		CareFusion	CareFusion	CareFusion	CareFusion
Supplier	Primary Australian distributor	CareFusion Australia 3/167 Prospect Hwy, Seven Hills, NSW 2147 1800 110 511	CareFusion Australia 3/167 Prospect Hwy, Seven Hills, NSW 2147 1800 110 511	CareFusion Australia 3/167 Prospect Hwy, Seven Hills, NSW 2147 1800 110 511	CareFusion Australia 3/167 Prospect Hwy, Seven Hills, NSW 2147 1800 110 511
Hardware	Portable or desktop	Portable	Portable	Desktop	Desktop
	Power supply	9V battery	Battery or mains power	Mains power	Mains power
	Sensor type	Turbine	Ultrasonic	Pneumotach	Heated pneumotach
	Is external PC (not supplied) required	No	No	Yes	YES
	Internal or external (not supplied) printer	External	External	External	External
	Weight (kg)	0.19	0.20	1.00	1.00
	Warranty period	18 months	18 months	One year	One year
Costs	Spirometer (ex GST)	\$1,695	\$2,675	\$6,750	\$7,250
	Disposables per patient (ex GST)	Mouthpiece @ \$0.25	Filter @ \$2.00	Filter @ \$2.00	Filter @ \$2.00
Software	Patient storage capacity	Nil, infinite with PC	500, infinite with PC	Infinite	Infinite
	Type of database	MS Access™	MS Access™	Microsoft SQL 2005	Microsoft SQL 2005
	Interpretation software included	Yes	Yes	Yes	Yes
	Results download to clinical software	Yes	Yes	Yes	Yes
	Provides feedback after each blow	Yes	Yes	Yes	Yes
	Provides grading of test quality	Yes	Yes	Yes	Yes
Reference Values	Reference values available	No, software required	Knudson, NHANES III, ECCS, +others	Knudson, NHANES III, ECCS, +others	Knudson, NHANES III, ECCS, +others
	Includes lower limit of normal	Yes, with software	Yes	Yes	Yes
	Can add additional reference equations	No	No	Yes	Yes
	Can adjust for ethnicity	Yes, with software	Yes	Yes	Yes
	Prints predicted flow-volume curve	Yes, with software	Yes	Yes	Yes
General Features	Indices measured	FEV <sub>1</sub> , FVC, FEV <sub>1</sub> /FVC, PEF, FEV <sub>6</sub>	FEV <sub>1</sub> , FVC, FEV <sub>1</sub> /FVC, PEF, FEF <sub>25-75%</sub> , + others	FEV <sub>1</sub> , FVC, FEV <sub>1</sub> /FVC, PEF, FEF <sub>25-75%</sub> , + others	FEV <sub>1</sub> , FVC, FEV <sub>1</sub> /FVC, PEF, FEF <sub>25-75%</sub> , + others
	Can user customise the final report	Yes	Yes	Yes	Yes
	Meets 2005 ATS/ERS performance standard	Yes	Yes	Yes	Yes
	Is printed report user definable	Yes	Yes	Yes	Yes
	Daily calibration check recommended	No	No	Yes	Yes
	Automatically adjusts calibration	No	No	Yes	Yes
	Curves displayed in real-time	No	Yes	Yes	Yes
	Prints volume-time / flow-volume curves	Yes, both	Yes, both	Yes, both	Yes, both
	Provides serial report	Yes	Yes	Yes	Yes
	Infection control precautions	Disposable filter	Disposable filter	Disposable filter	Disposable filter
	Report quantifies post-BD changes	Yes	Yes	Yes	Yes
	Supplied with user manual	Yes	Yes	YES, PDF format	YES, PDF format
	Training can be provided on purchase	Yes	Yes	Yes	Yes
Extra	Other key features	Cost effective simplicity	Touch screen	Laboratory standard; internet reporting available	Laboratory standard; internet reporting available