GIG CYMRU NHS WALES

Rhwydwaith Anadlol Respiratory Network

Protocol and Procedure for Undertaking and Interpreting Spirometry

Supporting notes

THE ALL WALES ASTHMA DIAGNOSIS

icst.info/the-all-Wales-asthma-diagnosis-guideline

THE ALL WALES ASTHMA MANAGEMENT & PRESCRIBING

icst.info/the-all-wales-asthma-management-and-prescribing-guideline

Cover Sheet – Key Changes

Changes made:

- Contraindications – alteration of phrasing to indicate that contraindications used in Primary Care may differ from those used in Secondary Care
- Preparing the patient – timeframes updated in line with The Association for Respiratory Technology & Physiology (ARTP) guidelines to ensure consistency across protocols
- Performing the procedure – updates made in line with ARTP guidelines, which include changes to reproducibility criteria
- Interpretation – information on Z-scores has been included, this is a more accurate way of interpreting Spirometry and users of this guide should be aware of how to implement
- Alteration to the pre-test instructions - which were altered in line with ARTP guidance. If the updated document wasn't followed, then the test could still go ahead, but the document sets out what the gold standard would be.

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1.0 PURPOSE

This document is designed to ensure the safety of the patient undertaking spirometry. The following procedures will ensure that there is a standardised practise across all Wales. This procedure must be kept up to date and will be reviewed every 3 years. It is designed to follow the Association for Respiratory Technology and Physiology (ARTP) guidelines on spirometry in addition to local guidelines on Clinical Record Keeping and Audit.

BACKGROUND

Spirometry is one of the main investigations used for diagnosing respiratory disease such as Chronic Obstructive Pulmonary Disease (COPD) and Asthma. Chronic lung disease is a major cause of mortality and morbidity in the UK. The prevalence of lung disease is predicted to increase during the next 20 years. There are thought to be approximately 3 million people in UK living with COPD, but less than 1 million have been diagnosed. COPD accounts for around 25% of deaths from lung disease and around 115,000 emergency hospital admissions per year (Society, 2019)

There is significant variation in care and outcomes both within the UK and internationally. In 2008 premature mortality from COPD was almost twice as high in the UK than the European average. There is a need to ensure that COPD is diagnosed at the earliest opportunity. It is the recommended objective test performed to identify abnormalities in lung volumes and air flow. It is used in conjunction with history taking, physical examination and imaging to exclude or confirm lung diseases, enabling timely diagnosis and treatment.

2.0 DEFINITION OF SPIROMETRY

Spirometry can be performed in all respiratory settings and is one of the essential lung function investigations in the diagnosis, assessment of severity, and monitoring of a number of respiratory conditions. Spirometry is the recommended objective test performed to identify abnormalities in lung volumes and air flow. It is used in conjunction with physical assessment, history taking, blood tests and x-rays, to exclude or confirm particular types of lung disease, enabling timely diagnosis and treatment. (Butterfield, 2019). Regular workplace spirometry is also used to screen for occupational respiratory disease and other lung function tests are available through specialist services.

Spirometry is done by measuring the volume of air that the patient is able to expel from the lungs after maximal inspiration.

THE MEASUREMENTS THAT ARE OBTAINED ARE:

VC – Vital Capacity	This is a non-forced measurement and may be greater than the FVC in COPD indicating air trapping. It gives an accurate measure of lung volume when the airways are floppy as in emphysema.
FVC – Forced Vital Capacity	This is the maximum volume of air that can be forcefully expired after maximal inspiration.
FEV1 – Forced Expiratory Volume in 1 second	This is the maximum volume of air that can be forcefully expired in the first second of the FVC
FEV1/FVC ratio	This is the ratio of Forced Expiratory Volume in 1 second and Forced Vital Capacity.

CONSENT

For consent to be valid it must be given voluntarily and freely without influence and undue pressure to accept or refuse treatment (Lavery, 2003). It can be assumed that patients consented to spirometry when their actions demonstrate this, for example attending an appointment and completing the relevant pre spirometry checks. This is regarded as implied consent and is valid. (WAG, 2008). A pre spirometry check list form has been devised to assist the health care professional to outline any contraindications and highlight need for BV filters pre spirometry this is shown in (Appendix 5).

CONFIDENTIALITY

Confidentiality must be adhered to at all times. Staff must follow the relevant policy for their Health Board.

3.0 WHO CAN PERFORM SPIROMETRY?

Diagnostic spirometry has to be performed to a high standard. If it is not, there is a significant risk that the diagnosis will be incorrect, and patients may receive inappropriate and potential harmful treatment as a result, or to be denied treatment that could potentially improve their condition. To be valid, diagnostic spirometry must be quality assured. It should only be performed by people that have been appropriately assessed as competent, demonstrating that they have achieved the standards established by (ARTP) for the performance and interpretation of spirometry measurements. Without this overall quality assurance, the accuracy of diagnosis cannot be relied upon (PCCCC, 2013).

4.0 TRAINING FOR STAFF UNDERTAKING SPIROMETRY

To ensure that spirometry has been performed effectively it is important that health care professionals (HCP) who carry out the test do so following ARTP guidelines. In the UK, the Association for Respiratory Technology and Physiology (ARTP), in conjunction with the BTS through the BTS/ARTP Liaison Committee, have established a qualification to assess the competence of staff to perform spirometry.

In September 2016 a document was released, improving the quality of the diagnostic spirometry in adults: the national register of certified professionals and operators. This should be used alongside "The Guide to Performing Quality Assured Diagnostic Spirometry" published in 2013, which describes how high-quality diagnostic spirometry should be delivered and provides a clear outline of the standards required.

Local ARTP spirometry training is now available. Health professionals can apply for the following levels:

Level 1 (foundation)	Level 2 (interpretation)	Level 3 (Full)
Those who have been deemed competent to perform safe accurate and reliable spirometry tests without interpretation.	Those who have been assessed in interpretation only.	Those that have been assessed as competent to perform and interpret spirometry in terms of psychological changes.

It is the HCP choice which level of competence is achieved in spirometry training. The Level 1 qualification is generally, but not exclusively, for healthcare support workers who perform spirometry only. The Level 2 qualification is generally, but not exclusively for General Practitioners, Pharmacists, Doctors within secondary care settings and Physiologists who may interpret spirometry results only. The level 3 qualification is generally, but not exclusively, for Practice Nurses and Respiratory Nurse Specialists, Advanced Practitioners and Respiratory Physiologists who perform and interpret spirometry. (See the institute of Clinical Science and Technology website for further information.

5.0 SPIROMETRY VERIFICATION/CALIBRATION

There are a range of spirometers used across the UK. The main spirometer used across primary care are handheld spirometers. Some spirometers link to computer software, where others have their own hard drive to store information. It is important to adhere to the spirometers manufacturing guidelines. It is vital that all spirometers are verified prior to clinical use, this should be done as shown:

- All components should be assembled according to the manufacturers' instructions and a new disposable one way mouthpiece should be in place.
- The spirometer and calibration syringe must be calibrated and serviced annually as per manufacturer's guidelines. (Some devices cannot be calibrated internally; however, all machines must be verified to see whether they read accurately)
- The spirometer calibration must then be verified prior to each clinic, to ensure accurate patient results, using a precision annually certificated verification 3L syringe - this must have an accuracy of +/-15ml.
- For the device to be within verification limits it must read +/- 3% of true.
- Verification should be performed prior to every clinic/session or after every 10th patient (whichever comes first).
- If verification fails correct any potential causes and retest – do not use if verification check fails. Document a log of problems as they arise.
- Verify (Calibrate) spirometer according to manufacturer guidelines and if continues to fail verification contact manufacturer.
- Document all repairs and computer software updates related to the spirometer.
- Calibration syringes should be maintained at same temperature and humidity as the spirometer. Spirometers do not respond well to movement and changes in temperature and as a result if performing the procedure in a different area or in a patient's home verification may need to be re performed.
- If using a handheld spirometer this device will still need to be calibrated and verified as per manufacturing instructions.
- All verifications and calibrations should be stored either in the equipment software, or preferably in a calibration logbook for the equipment (Appendix 2).

This is the only proof of reliability of the equipment.

6.0 BIOLOGICAL QUALITY CONTROL

- Quality control ensures that all aspects of a procedure produce reliable and reproducible results and should be performed on a regular basis
- A physiological control should therefore be used to identify any inconsistencies.
- A member of staff free of known active respiratory disease is required to determine their normal physiological range by recording their spirometry daily, at the same time of day for 2 weeks. At least 10 recordings are required (Appendix 3).
- It needs to be the same member of staff each time so if that member of staff leaves then the biological control will need to be obtained again for another staff member.

- It is then necessary to calculate the mean (average) value for each lung function parameter and then to calculate the normal range. This will be plus or minus 5% of the mean of each parameter.

- Once this range has been established then they can be used to verify the accuracy of the spirometer and produce a set of results that can be compared over time.

7.0 INFECTION CONTROL SPIROMETER CLEANING

All spirometers need to be cleaned as per spirometer manufacturing instructions and Local Health Board Policy. Ensure that you follow the spirometer manual for specific cleaning instructions for any variance, as every model of spirometer has different cleaning recommendations, however in general:

- Single use one-way mouthpieces or bacterial/viral (BV) filter and single patient nose clips should be used

- Alcohol wipes should be used to clean external surfaces of spirometer and tubing after each patient use. Most Manufactures suggest the use of 70% isopropyl alcohol impregnated cloth

- Once a week the spirometer should be decontaminated by a designated Health Care Professional as per manufacturer's instructions – the Spirometer should be dissembled and all parts as mentioned in manual should be cleaned, ideally in a stainless-steel bowl

- Washed in hot water containing detergent (washing up liquid)

- Rinsed well in tap water/distilled water

- Some spirometers need to be decontaminated/sterilised in Perasafe solution ensuring all parts are totally submersed in the solution for ten minutes (once a month). Please adhere to Spirometry Manual to identify if this is required

- Rinsed well in tap water/distilled water

- Allowed to air dry thoroughly before reassembly. For some spirometers the spirometer will need to be dried over the weekend as the capillary network within the spirometer can take approx. 24-48hrs to dry.

- Weekly decontamination should be documented in Cleaning Log (Appendix 4)

- The spirometer should be calibrated/verified after cleaning prior to use

SUSPECTED INFECTED / IMMUNOCOMPROMISED PATIENT, SPIROMETER CLEANING

- Patients who are Immunocompromised should be first to use the spirometer after decontamination to reduce risk of cross infection.

- If a patient has suspected infection/risk or immunocompromised then it is essential that a bacterial viral (BV) filter is used.

- Spirometry is contraindicated in patients suspected of untreated respiratory TB, infective patients and patients who have had a respiratory infection in last 6 weeks – if the spirometer is to be used on a potentially infective patient please speak to GP or Consultant to determine if test is to continue. If required, these patients should have spirometry complete, and the end of the daily list and the equipment decontaminated after use as per manufacturer's instructions prior to use by another patient.

Hand washing is essential between every patient and gloves should be worn when handling potentially contaminated equipment. Please adhere to Local Heath Board Policy.

8.0 WHO CAN HAVE SPIROMETRY?

Most patients can undergo spirometry. Spirometry can be undertaken within Primary, Community and Secondary care. Spirometry will be performed to:

1. Aid the diagnosis of a lung condition
2. To rule out a lung condition
3. To complete Reversibility testing using short acting bronchodilators. A Patient Group Directive (PGD) is essential to allow the Qualified Health Care Professional to administer the medication to the patient. No drugs should be administered without a PGD or prescription.
4. To monitor effectiveness of treatment.

There are certain contra-indications that need to be ruled out before performing spirometry. Please see (appendix 5) for the check list and patient consent form. This will be discussed between the Health Care Professional and patient pre spirometry, form completed and signed then filled or scanned onto patient record in primary care and added to the notes in the community or secondary care documentation.

CONTRAINDICATIONS TO SPIROMETRY

Relevant contraindications need to be reviewed with the patient prior to testing and documented on the spirometry report. Where the operator has any doubt about the safety of testing it is their responsibility to discuss this with the GP, their respective head of department or referring physician's team prior to testing. The majority of contraindications are relative but where there is potential for risk to occur, the benefit of performing the test should be compared to the potential risk and a decision made whether the benefit outweighs the risk. Some relative contraindications in secondary care may be absolute in primary care, depending on local protocols

ABSOLUTE CONTRAINDICATIONS

- Active infection e.g. AFB positive TB until treated for 2 weeks
- Conditions that may cause serious consequences if aggravated by forced expiration, e.g. dissecting / unstable aortic aneurysm, current pneumothorax, recent surgery including ophthalmic, thoracic, abdominal or neurosurgery

RELATIVE CONTRAINDICATIONS

- Suspected repiratory infection in the last 4-6 weeks
- Undiagnosed chest symptoms e.g. Haemoptysis
- Any condition which may be aggravated by forced expiration e.g. haemoptysis, history of prior Pneumothorax; unstable vascular status such as recent (within 3 months) myocardial infarction, uncontrolled hypertension or pulmonary embolism or history of haemorrhagic event (Stroke); previous thoracic, abdominal or eye surgery
- Patient is too unwell to perform forced expiration
- Communication problems such as learning disability or confusion

9.0 PREPARING THE PATIENT

Spirometry can be undertaken 'opportunistically' but it is very helpful for the patients if they are aware of what to expect and can therefore come prepared. It is important that the patient is aware of the procedure and what will happen during the procedure. The patient also needs to know what to do in order for the results to be as accurate as possible.

If possible ask patients to **AVOID**:

1. Refrain from eating a substantial meal for at least 2hours prior to the test.
2. Avoid smoking on the day of the test
3. Avoid wearing clothing which substantially restricts full chest and abdominal expansion
4. Avoid vigorous exercise for at least 30min prior to the test
5. Not consume alcohol for at least 4hours prior to the test

If Baseline, diagnostic or bronchodilator reversibility testing is needed then the patients will also be required to STOP:

6. Short-acting inhaled β2 agonists for 4 hours
7. Long-acting inhaled β2 agonists for 12-24 hours
8. Long-acting inhaled anticholinergics for 36 hours
9. Theophylline's for 24 hours

(PCCCC 2013)

If routine monitoring of disease is carried out in an Asthma or COPD review there is no need to stop inhalers.

Before the test determine type of spirometry required:

1. Baseline spirometry: to investigate lung function where a diagnosis has not been established or to determine improvement in respiratory symptoms.
2. Reversibility testing may be helpful to differentiate asthma from COPD. It should not be used in isolation but as part of a clinical assessment.
3. Post bronchodilator spirometry: to investigate and diagnose obstructive conditions where baseline spirometry shows an obstructive picture, or to monitor clinical progress in diagnosed Asthma and COPD. The patient needs to be established on treatment to complete post bronchodilator spirometry.

A patient information leaflet has been designed for the service to help prepare the patient for their spirometry and should be sent out prior to their appointment (Appendix 1).

PROCEDURE	RATIONALE
1. Check calibration of the spirometer using a 3 litre syringe	To ensure that the spirometer is accurate and no variance in the parameters in the machine have occurred.
2. Wash hands before testing.	To ensure no cross contamination.

3. Go through the patient pre spirometry check list with the patient. DO NOT proceed if the patient has any contraindications.	To ensure that they have followed the necessary requirements prior to testing (Document anything that could alter results i.e. Medication taken).
4. Explain the test fully to the patient and what is expected of them.	To be able to obtain the patients full informed consent.
5. Obtain the patients Age, Sex, Ethnicity, Weight and measure height without shoes. If the patient has spinal deformities then obtain height by measuring their arm span.	To accurately calculate reference values.
6. Ask the patient to sit down in a chair with arms, remove any tight clothing and if they have loose dentures to remove.	Patients may feel dizzy or lightheaded and may faint during testing.
7. Ensure patient is comfortable and does not have a full bladder.	This will influence who hard they can blow.
8. Check all the patients details are correct (age, gender, name, hospital number, etc.) and enter these details in the spirometer.	To ensure you have the correct patient and correct details are on the results.
9. Demonstrate clearly to the patient how to perform the Vital Capacity (VC) by putting the disposable mouthpiece to your mouth, between your teeth and sealing your lips around it.	To enable to patient to fully understand what is required with the aim of reducing the need for repeat blows.
10. Apply nose clip	To prevent air leaking from the nose and producing a reduced reading.
11. Ask the patient to perform the VC and repeat the manoeuvre to get 3 technically acceptable efforts. The VC values should not differ by more than 150mL.	This measures the potential capacity of the lungs at rest and is compared against the forced blow. It may take more than 3 attempts to ensure reproducibility criteria are met, so allows the patient to rest between blows.
12. Demonstrate clearly to the patient how to perform the forced vital capacity (FVC) by putting your disposable mouthpiece to your mouth between your teeth and sealing your lips. Perform the breath yourself.	To enable to patient to fully understand what is required with the aim of reducing the need for repeat blows.
13. Ask the patient to perform the VC and repeat the manoeuvre to get 3 technically acceptable efforts. The FEV1 and FVC values should not differ by more than 150mL. If the FVC is <1.0L, this difference should not be greater than 100mL. The PEF values should not differ by more than 40L/min (0.67L/s).	This measures the potential capacity of the lungs at rest and is compared against the forced blow. It may take more than 3 attempts to ensure reproducibility criteria are met, so allows the patient to rest between blows.

14. For each FVC blow encourage the patient loudly saying "Blow hard, blow, blow blow..."	To ensure that maximal effort has been obtained as this is essential to demonstrate any abnormality.
15. Examine if the ARTP criterion has been achieved	To ensure that the best of 3 readings are acceptable for interpretation.
16. Print off a copy of the results for interpretation and write any issues with technique.	This will help the clinician gage the reliability of the results. Also document any medication taken pre testing.
17. Scan the results in to the computer and save on the shared drive/scan onto patient document. If software available upload straight onto patient notes	Please note printed paper from the spirometer does not withstand age and will deteriorate over time. Try and scan or upload onto patient notes.

10.0 POST BRONCHODILATOR SPIROMETRY & DIAGNOSTIC SPIROMETRY WITH REVERSIBILITY

- Spirometry with reversibility is performed for diagnostic purposes such as to help differentiate between asthma and COPD. Post bronchodilator spirometry is required for confirmation of COPD.
- A spacer (Aerochamber plus Flow-vu) will need to be prescribed for the patient pre assessment. The spacers are single patient use only.
- If assessing reversibility, record baseline spirometry.
- Ensure medication is withheld as specified in the Patient Information Leaflet
- Administer bronchodilator as prescribed (usually 4 x 100mcg Salbutamol as single puffs via spacer) (A PGD will be required for qualified nurses that are not non-medical prescribers, please adhere to the local PGD salbutamol reversibility document). If not available the GP must prescribe Salbutamol for the patient.
- Perform or repeat spirometry after 20 minutes
- Degree of reversibility is based on changes in Forced Expiratory Volume in 1 second (FEV1). The ATS/ERS Guidelines specify a positive bronchodilator response as >12% and 200ml in FEV1. As guidelines differ, please ensure that you document on the report which guidelines have been used to interpret the results.

The percentage improvement in FEV1 can be calculated as follows:

$$\frac{\text{(Post bronchodilator FEV1 – Pre bronchodilator FEV1)}}{\text{Pre bronchodilator FEV1}} \times 100$$

11.0 COMMON ERRORS

It is not always easy to see if a patient is performing effective breaths for the accurate interpretation of spirometry, therefore it's important to observe both the patient and trace throughout the procedure. Some spirometers will record errors on results i.e. slow start. There are a number of errors that can occur during the testing. All of these errors will mean that the test should be repeated.

These are:

1. A leak at the mouth
2. An obstructed mouthpiece due to tongue or false teeth
3. A poorly coordinated start to the manoeuvre
4. A cough within the first second of the manoeuvre, or a later cough if it is deemed to have interfered with the blow
5. Early termination of the blow
6. If the patient did not inspire to Total Lung Capacity (TLC)
7. The expiratory effort was sub-maximal

(ARTP 1994)

12.0 INTERPRETATION OF RESULTS

As part of the ARTP spirometry training at Level 2 or 3 throughout the workshop, e – modules and OSCE you will learn and be assessed on interpretation of the results.

These are the four basic patterns to recognise:

Normal	FEV1 and FVC above 80% predicted AND FEV1/FVC ratio above 0.7 or above Lower limit of normal (LLN).
Obstructive	FEV1/FVC ratio below 0.7 or LLN FEV1 generally reduced below 80% predicted The exemption is where Fev1 is over 80%, the ratio is below 0.7 or LLN, however there is scooping in the flow volume curve FVC normal (above 80% predicted)
Restrictive	FVC reduced below 80% predicted (however, Restrictive Lung Disease cannot be diagnosed on spirometry alone) FEV1 generally reduced below 80% FEV1/FVC ratio normal – above 0.7 or LLN
Mixed pattern	FEV1/FVC ratio below 0.7 or LLN FVC reduced below 80% predicted

Several organisations have sought to simplify the diagnosis of airflow limitation by replacing the lower limit of normal (LLN) with a fixed cut off of 0.70. However, since the FEV1/FVC ratio depends age, height, sex, this leads to over-diagnosis of obstructive lung disease in elderly subjects, and to under-diagnose in young subjects. Therefore, the presence of obstructive lung disease should be based on the FEV1/FVC ratio below the LLN.

If a patient has an obstructive picture on spirometry, this could also indicate asthma, chronic asthma and bronchiectasis so a detailed holistic assessment, history and further investigations may need to be complete to provide an accurate diagnosis.

It is important to look at the flow-volume curves as this provides a quick and simple check on whether or not obstruction is present in the results. A quick table as shown below identifies key features of abnormality in obstructive restrictive and mixed disease conditions. The grey boxes highlight the primary features of the abnormal patterns. For example, a reduced FEV1/FVC ratio is the primary spirometric abnormality in Obstructive Lung Disease; the FEV1 is then used to define severity of airflow Obstruction, and the FVC is used to identify any overlapping restrictive element (i.e. a mixed pattern).

Example a reduced FEV1/FVC ratio is the primary spiro-metric abnormality in Obstructive Lung Disease; the FEV1 is then used to define severity of airflow obstruction, and the FVC is used to identify any overlapping restrictive element (i.e. a mixed pattern).

Features of ventilatory abnormality in spirometry			
	Obstructive	Restrictive	Mixed
FEV1	Normal or reduced	Reduced	Reduced
FVC	Normal or elevated	Reduced	Reduced
FEV1/FVC	Reduced	Normal or increased	Reduced

For people with a COPD diagnosis the only way to interpret the severity is by undertaking spirometry. Other measures, such as the MRC dyspnoea scale for measuring breathlessness, exacerbation frequency, body mass index, quality of life assessment, and exercise capacity all help to build a more complete picture (Conditions, 2010).

COPD IS CLASSIFIED INTO 4 CATEGORIES OF SEVERITY DEPENDING ON THE SPIROMETRY RESULTS

		GOLD (2019) **NICE Clinical guideline (2018)**
Post bronchodilator FEV1/FVC	FEV1 % predicted	
<0.7 or LLN	>80%	Stage 1 – Mild*
<0.7 or LLN	50-79%	Stage 2 – Moderate
<0.7 or LLN	30-49%	Stage 3 – Severe
<0.7 or LLN	<30%	Stage 4 – Very Severe**

* Symptoms should be present to diagnose COPD in people with mild airflow obstruction ** Or FEV1 <50% with respiratory failure, PO2 <7.3Kpa and meets criteria for Long term Oxygen Therapy (LTOT).

13.0 REFERENCE LIST

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ARTP Spirometry Standard Operating Procedure - Performance of spirometry in Adults 11th May 2023
SpirometryStandardOperatingProcedureMay2023V2.docx

ARTP statement on pulmonary function testing 2020
ARTP statement on pulmonary function testing 2020 | BMJ Open Respiratory Research

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APPENDIX 1 – PATIENT INFORMATION LEAFLET

Spirometry testing (Lung Function)

Your doctor or nurse has asked us to arrange a Spirometry test either to establish a diagnosis or as part of your ongoing review

It is important you take a few minutes to read this leaflet before your appointment

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PLEASE NOTE

If you have had this test performed in the last 6 weeks, please telephone the practice to confirm if the test is still necessary.

If you are unable to attend your appointment, please inform the surgery as soon as possible.

If you are worried about the test in any way, please contact the practice to discuss your concerns

Patient Stamp

THE TEST

The purpose of this lung test is to determine how well your lungs are working by measuring the amount of air you can breathe in and out. You will therefore be asked to blow into a machine with a nose clip on your nose. It may also be necessary to repeat the test after you have taken an inhaler. You doctor or nurse will decide if this is required.

This test takes approximately 30-45 minutes

BEFORE

Before the test please avoid:

Eating a large meal 2 hours before
Drinking alcohol 4 hours before
Vigorous exercise 30 minutes before
Smoking for at least 24 hours before
Wearing tight clothing that may restrict your breathing during the test

Please contact the practice if you have experienced any of the following:

Recent chest infection in last 6 weeks
Recent eye, stomach or chest surgery
Attended A&E in last 2-3 days
Chest pain on day of your test

If you use inhalers, please try not to take your reliever Salbutamol (Ventolin) or Brincanyl

4 HOURS BEFORE THE TEST

If you find difficult to manage without your inhaler, please use it and make a note of the time. When you arrive for you test please tell us if you have used your inhaler and at what time.

All other medications should be taken as directed by your doctor or nurse.

AFTER

The results of the lung function test will be sent to the doctor or nurse who requested the investigation, and the results will be discussed with you at your next clinic appointment.

APPENDIX 2 – CALIBRATION/VERIFICATION LOG

Syringe Volume			
Date and Time	**Syringe volume input**	**% Difference**	**Acceptable?**

APPENDIX 3 – PHYSIOLOGICAL QUALITY CONTROL LOG

Date	Peak Expiratory Flow *(litres/second)*	FEV1 *(litres)*	FVC (*litres*)	FEV1/FVC *(%)*
Mean				
Acceptable range (± 5% mean)				

APPENDIX 4 – CLEANING SCHEDULE

Date and Time	Patient testing area	Spirometer	Peak Flow Meter	Inspection of the devices	Initials
EXAMPLE 07/12/14 11:30am	✓	✓	*N/A*	*Slight loose connection of the cable – manufacturer contacted*	*AB*

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APPENDIX 5 – SPIROMETRY CHECKLIST

Prior to coming for this Spirometry test you will have received instructions, either verbally/ letter/leaflet explaining what the test involves and how to prepare for it. While you are waiting for the test, we would be grateful if you could answer the following questions, your nurse will support you with the parts of this form that you don't understand.

NAME: _____ DOB: _____

ETHNICITY: _____

INHALERS: (where prescribed) _____

What time did you use your rescue short acting bronchodilator e.g. Ventolin or Terbutaline (Bricanyl)?	
What time did you use your long acting bronchodilator e.g. Anoro, Onbrez Oxis or Salmeterol	
What time did you use your anticholinergic e.g. Atrovent, Braltus, Genuair, Incruse, Seebri, Respimat or Spiriva?	
What time did you use preventer / combination inhaler e.g. Clenil, Fostair, Flixotide, Flutiform Qvar, Relvar, Seretide, Symbicort, Trelegy, Trimbow.	
If you are taking Theophylline what time did you take your last dose?	
Do you smoke? YES / NO If YES what time was your last cigarette?	
Have you eaten a large meal before coming for this test and what time?	

IN THE LAST 3 MONTHS HAVE YOU EXPERIENCED ANY OF THE FOLLOWING?

Chest Pain	YES	NO
Heart Attack	YES	NO
Unstable Angina	YES	NO
Stroke / CVA	YES	NO
Hernias / Aneurysms	YES	NO
Abdominal Surgery	YES	NO
Are you Pregnant	YES	NO
Haemoptysis of unknown origin (coughing up blood)	YES	NO
Pneumothorax (collapsed lung)	YES	NO

Chest Surgery	YES	NO
Pulmonary Embolism (clot on lung)	YES	NO
Eye Surgery/Cataract/Glaucoma Problems/laser eye treatment (48hrs)	YES	NO
Perforated tympanic membrane (ear drum)	YES	NO
Recent Chest Infection requiring antibiotics (within 6 weeks)	YES	NO
TB/High Risk (use BV Filter)	YES	NO

BEFORE THE TEST, PLEASE ENSURE YOU:

Remove chewing gum, ensure your bladder is empty, and loosen any tight clothing which would restrict breathing. You may also want to remove any loose fitting dentures.

Height	
Weight	
Blood pressure mmHG (Do not perform if hypertensive 160/100)	
HR	
Oxygen saturations (Do not perform if less than 92% on air)	

Comments:

Patient Signature: _____

Date: _____

Health Care Professional signature: _____

Continue with test? YES / NO

APPENDIX 6 - DEFINING THE LOWER LIMITS OF NORMAL (LLN)

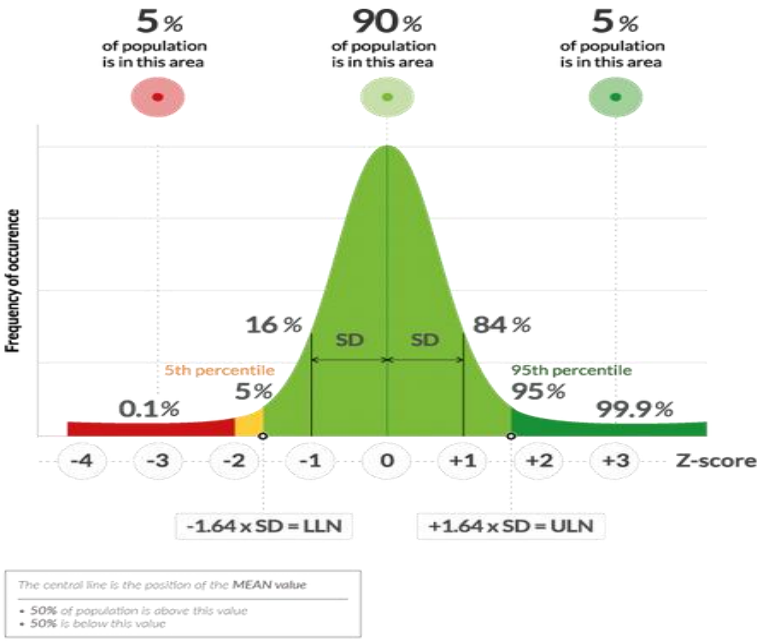
The use of percent predicted when assessing lung function is widely used and an 80% 'cut-off' for a lower limit of normal (LLN) is commonly utilised and considered during diagnosis and monitoring of respiratory disease. However, the 80% of predicted 'cut-off' for what may be considered 'normal' is not based on any scientific foundation and has been considered as statistically invalid. As many authors in the past have shown, scatter plots of data of respiratory parameters such as FEV1 show in healthy non-smokers, a proportional change of scatter as the value declines with age. As such, a LLN should follow the same pattern.

When looking at the raw data scatter using 80% predicted LLN shows a progressively increasing LLN as age increases with no statistical reasoning. Implementing this as a marker of abnormality, would create a large percentage of false-positive results in both young and elderly subjects. Additionally, with an ever increasing ageing population, this could be regarded as a potential problem when diagnosing and monitoring respiratory disease (Roebuck 2021).

The Z score

The normal range can be represented as a pictogram as shown below, or as Z-scores, in which 95% of healthy subjects will have Z-scores within ±2 z-scores, and 90% within ±1.645 z-scores. The Z-score indicates how many standard deviations a measured value is from predicted.

Use of Z-scores solves many potential problems by taking into account age, height, sex and ethnic group, as well as the age-dependent reference range. Unlike % predicted, it is therefore free of any bias. An obvious advantage is that any given Z-score indicates comparable lung function between individuals, irrespective of their sex, height, age or ethnicity. The Z-score also facilitates bias-free interpretation of serial measurements within a person during growth and ageing, and direct comparison between different lung function outcomes.



The ARTP recommends a revised classification of airway obstruction:

ARTP CLASSIFICATION USING Z-SCORES		
FEV1/FVC Ratio	**FEV1 Z-Score**	**Severity**
<LLN or -1.645	< -1.645	Mild
<LLN or -1.645	< -2.00	Moderate
<LLN or -1.645	< -2.50	Moderately Severe
<LLN or -1.645	< -3.00	Severe
<LLN or -1.645	< -4.00	Very Severe