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Spirometry The Basic

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Introduction

Spirometry is an essential investigation for diagnosis and severity assessment in people with COPD and other respiratory conditions.

Most COPD is undetected: around 835,000 people have been diagnosed in England, while 2.2 million people are living with COPD but do not know they have the condition. Over half those with moderate and severe disease and the vast majority of those with mild disease are undiagnosed.

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Spirometry is used in conjunction with clinical assessment for diagnosis of lung disease, but also for case-finding and disease monitoring. For case-finding, clinicians may use rapid non-diagnostic spirometry to exclude people who have symptoms but normal lung function - those with abnormal results then proceed to diagnostic spirometry. FEV1 monitoring is also used by GPs to monitor changes in air flow obstruction over time as required by QOF. However, when used for diagnosis of disease spirometry must be quality assured and should only be performed to an approved standard – without this assurance the validity of the diagnosis cannot be relied on

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Equipment requirements and standards

- One-way mouthpieces and nose clips
- Bacterial and viral filters (as indicated in selected patients)
- Height measure and weighing scales – calibrated according to manufacturer's instructions.
- Nebuliser or single patient use volumatic (for post bronchodilator spirometry and reversibility testing)
- Single-patient use mask/mouthpiece for nebuliser
- Short acting bronchodilators as per guidelines (see below)

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Calibration

Calibration of spirometry test equipment should be performed using a 3 litre syringe following the manufacturer's recommended procedures. For the device to be within calibration limits it must read +/- 3% of true3. Calibration should be verified prior to every clinic/session or after every 10th patient (whichever comes first). A calibration log should be maintained.

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The standard

- Use an annually certificated calibration/verification
- 3L syringe - this must have an accuracy of +15ml
- Document calibration/verification results consistently, including a simple log of problems as they arise
- Document all repairs and computer software updates related to each specific spirometer.

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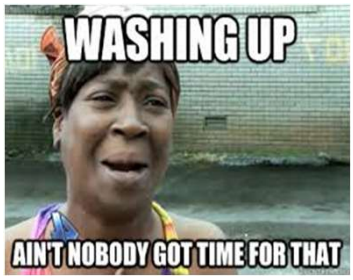
Cleaning

Any necessary cleaning and maintenance processes should be carried out on a regular basis according to manufacturer's instructions4 with reference to local guidelines and protocols



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Performing Spirometry

Assess the patient for contra-indications to spirometry. It should not be assumed that these have already been assessed by the referrer, and for some patients a degree of clinical judgement will be required in interpreting contraindications.

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Who can perform spirometry?

- **An operator trained and assessed to ARTP or equivalent standards in the**
- **performance of spirometry by recognised training bodies.**
- **Interpretation of results may be performed separately by a practitioner**
- **trained and assessed to ARTP or equivalent standards in the interpretation of spirometry by recognised training bodies.**
- **When used for diagnosis of disease spirometry must be quality assured and should only be performed to an approved standard – without this assurance the validity of the diagnosis cannot be relied upon.**
- **Are you happy with the reliability of the recording?**

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Step 1:

Assess the patient for contra-indications to spirometry. It should not be assumed that these have already been assessed by the referrer, and for some patients a degree of clinical judgement will be required in interpreting contraindications

Absolute

Active infection e.g. AFB positive TB until treated for 2 weeks

Conditions that may be cause serious consequences if aggravated by forced expiration e.g. dissecting /unstable aortic aneurysm, current pneumothorax, recent surgery including ophthalmic, thoracic abdominal or neurosurgery

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Relative

- **Suspected respiratory infection in the last 4-6 weeks**
- **Undiagnosed chest symptoms e.g. haemoptysis**
- **Any condition which may be aggravated by forced**
- **Expiration e.g. history of prior pneumothorax; unstable vascular status such as recent (within 1 month) myocardial infarction, uncontrolled hypertension or pulmonary embolism or history of haemorrhagic event (stroke);**
- **Previous thoracic, abdominal or eye surgery**
- **If the patient is too unwell to perform forced expiration**
- **Communication problems such as learning disability**

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Measure the patient's height and weight. Enter required values into the spirometer

Step 2:

- **Height – measured without shoes. If unable to measure height use arm span instead.**
- **Age and gender**
- **Ethnicity – this should be entered as per spirometer manufacturer's instructions.**

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Step 3:

Explain and demonstrate the procedure to the patient so that they understand what is required of them, and why it is important to perform each manoeuvre as best they can. You will need to explain that there will be two different blows performed for this procedure; the Vital Capacity (VC) and the Forced Vital Capacity (FVC), and that they will need to perform each type of blow on several occasions

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Step 4: Prepare patient and equipment to perform the baseline VC.

Apply nose clip.

Patient is sitting comfortably

A minimum of three acceptable VC manoeuvres must be obtained.

Repeatability criteria are met when there is no more than 100mls ideally (and certainly no more than 150mls

in the occasional highly variable patient) between each blow. Some spirometers will inform the user when this has been achieved.

Verbally encourage patient to continue to exhale as long

as possible

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Observe both patient and the time volume curve as each VC is performed to

<u>Ensure they</u>

Breathe in to maximal inspiration

Do not obstruct the mouthpiece with their teeth or tongue.

There are no leaks from the mouthpiece

Remove false teeth if loose

Usually this will be achieved within no more than four VC manoeuvres

If the patient is unable to achieve the quality criteria, record why this has not been possible. Another appointment may be required, or refer for specialist assessment.

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Step 5:Prepare the patient and the equipment to perform the baseline FVC.

- Nose clip is not essential.
- Patient is sitting comfortably
- A minimum of three acceptable FVC manoeuvres must be obtained.
- Repeatability criteria are met when there is no more than 100mls ideally (and certainly no more than 150mls in the occasional highly variable patient) between each blow.
- Some spirometers will inform the user when this has been achieved.
- Encourage maximum effort at the start of each blow, verbally encouraging patient to continue to exhale to achieve maximal effort

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Observe the patient as each FVC is performed to ensure they

Breathe in to maximal inspiration

Do not obstruct the mouthpiece with their teeth or tongue.

There are no leaks from the mouthpiece

Remove false teeth if loose

Observe the flow/volume curve as each FVC manoeuvre is being performed to identify:

Slow starts

Early stops

Variability in flow within manoeuvre

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Do not perform more than eight FVC manoeuvres in one session. If the patient is unable to achieve these standards - record why this has not been possible, arrange a further appointment to repeat the test if appropriate, or refer for specialist assessment

Record baseline spirometry results in electronic or paper template, using the largest FEV1 and VC or FVC (performed to standard) to determine the FEV1/VC ratio.

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Step 7: Post-bronchodilator testing

- **Post-bronchodilator spirometry testing should be performed if baseline spirometry reveals an obstructive picture, if reversibility testing is required (to differentiate asthma and COPD) and for chronic disease monitoring. Bronchodilator administration should be standardised as follows:**
- **Administer bronchodilator (usually 4 x 100mcg salbutamol as single puffs via spacer or 2.5mg via nebuliser)**
- **Perform spirometry after 15 minutes**

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Step 8:

Record post-bronchodilator spirometry results in electronic or paper template using the largest post-bronchodilator FEV1 and largest VC or FVC to determine the FEV1/VC ratio6 Ensure there is also a copy of the trace attached to the patient's healthcare records. The use of spirometry electronic templates is preferred because it promotes continuity of care, effective communication across service providers, and data retrieval for audit purposes.

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Very Important

In primary care the VC should always be measured and recorded, as well as the FVC. The ratio (FEV1/VC) should be calculated using whichever is the higher of the VC measurements, the baseline VC or FVC.

Spirometry reporting across healthcare communities should be provided in an agreed and uniform manner, ideally involving use of FEV1, FVC and VC and using data highlighting lower limit of normal values

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Follow Up

- Arrange interpretation of the spirometry results by a competent interpreter
- Ensure the patient has a follow up appointment arranged for the results to be explained and to arrange on-going management.

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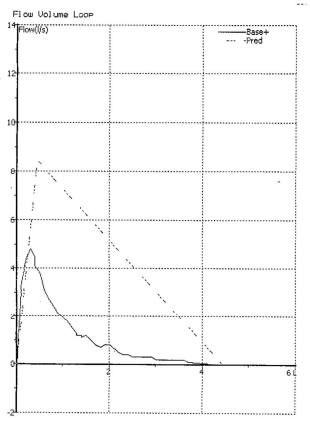

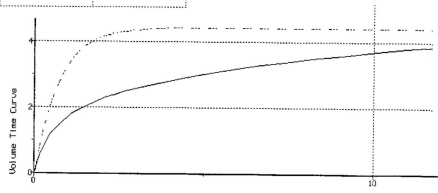

Sex: Male Age: 68
Factor: 100(Caucasian)
Height: 183cm Weight:_____kg

Turbine Transducer

(* is for auto best; ^ for manual best)

	VC	Var	Warning	Time: Date:
Base	4.11	*	(Good blow)	16:24 21/05/15
Base	3.99	-2%	(Good blow)	16:23 21/05/15
Base	3.93	-4%	(Good blow)	16:22 21/05/15

BTS Quality Criteria (Relaxed):
Base: Met.

	FEV1	FVC	FEV1/FVC	PEF	Var	Warning	Time:
Base Date: 21/05/15							
Base	1.74	3.99	43.6	269	-2%	(Good blow)	16:28
Base	1.73	4.16	41.6	288	*	(Good blow)	16:29
Base	1.69	3.86	43.8	241	-5%	(Good blow)	16:30

Variation is based on FEV1 + FVC.

BTS Quality Criteria (Forced):
Base: Met

Any forced data and graphs following are either best individual values or composite curve.

Best Spirometry Result:

	Base	%Pr	Min	Pred	Max	Post	%Pr	%Chg
	!-- Normal --!!--- Post! ---!							
FVC	4.11	89	3.69	4.61	5.53			!
VC	4.11	89	3.69	4.61	5.53			!
FEV1	1.74	51	2.37	3.41	4.25			!
FVC	4.16	94	3.43	4.43	5.43			!
PEF	288	57	388	508	627			l/min
FEV1/VC	42							%
FEV1/FVC	42	56	63	75	87			%

Lung Age 90yrs
Interpretation (Nice (2010)):
Base: Obstruction.

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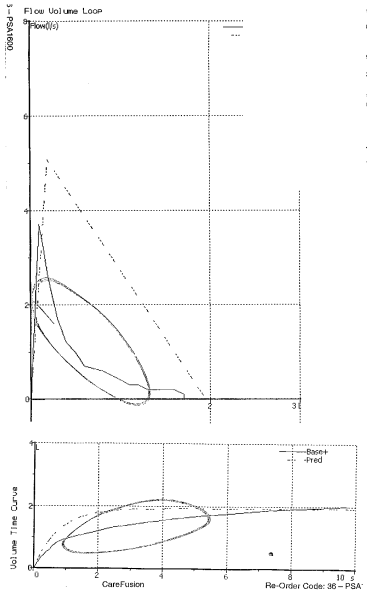

Sex: Female Age: 87
Factor: 100(Caucasian)
Height: 160cm Weight:_____kg

Turbine Transducer

(* is for auto best; ^ for manual best)

	VC	Var	Warning	Time: Date:
Base	1.90	*	(Good blow)	11:10 19/01/16
Base	1.80	-5%	(Good blow)	11:10 19/01/16
Base	1.73	-8%	(Good blow)	11:12 19/01/16
Base	1.49	-21%	(Good blow)	11:09 19/01/16

BTS Quality Criteria (Relaxed):
Base: Met.

	FEV1	FVC	FEV1/FVC	PEF	Var	Warning	Time:
Base Date: 19/01/16							
Base	0.92	1.65	55.8	230	-14%	(Good blow)	11:14
Base	0.89	1.98	44.9	221	-4%	(Good blow)	11:16
Base	0.92	2.09	44.0	141	*	(Good blow)	11:16

Variation is based on FEV1 + FVC.

BTS Quality Criteria (Forced):
Base: Not Met. Greatest 2 FVCs differ by 110ml.

Any forced data and graphs following are either best individual values or composite curve.

Best Spirometry Result:

	Base	%Pr	Min	Pred	Max	Post	%Pr	%Chg
	!-- Normal --!!--- Post! ---!							
FVC	1.90	99	1.22	1.91	2.60			!
VC	1.90	99	1.22	1.91	2.60			!
FEV1	0.92	55	0.93	1.55	2.17			!
FVC	2.09	108	1.23	1.94	2.65			!
PEF	230	75	216	305	394			l/min
FEV1/VC	48							%
FEV1/FVC	44	61	62	73	83			%

Lung Age 90yrs
Interpretation (Nice (2010)):
Base: Obstruction.

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Sex: Male Age: 84
Factor: 100(Afro-Caribbean)
Height: 172cm Weight: ____kg

Turbine Transducer

(* is for auto best; ^ for manual best)

	VC	Var	Warning	Time:	Date:
Base	1.44	*	(Good blow)	11:13	23/02/16
Base	1.41	-2%	(Good blow)	11:14	23/02/16
Base	1.26	-12%	(Good blow)	11:12	23/02/16

BTS Quality Criteria (Relaxed):
Base: Met.

	FEV1	FVC	FEV1/FVC	PEF	Var	Warning	Time:
Base Date: 23/02/16							
Base	0.92	1.42	64.8	179	0%	(Good blow)	11:16
Base	0.90	1.44	62.5	149	*	(Good blow)	11:17
Base	0.85	1.42	59.8	148	-2%	(Good blow)	11:21
Post1 Date: 23/02/16							
Post1	1.00	1.41	70.9	159	-1%	(Good blow)	11:38
Post1	1.00	1.45	69.0	163	0%	(Good blow)	11:39
Post1	0.97	1.48	65.5	116	*	(Good blow)	11:40

Variation is based on FEV1 + FVC.

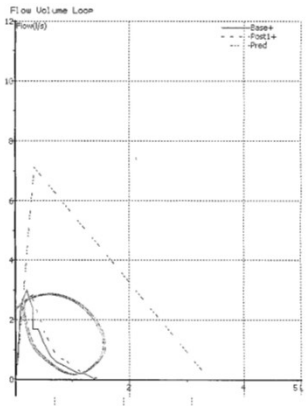
BTS Quality Criteria (Forced):
Base: Met
Post1: Met

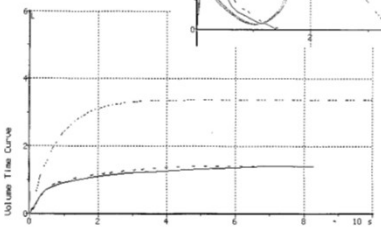
Any forced data and graphs following are either best individual values or composite curve.

Best Spirometry Result:

	Base	%Pr	Min	Normal Pred	Max	Post	%Pr	%Chg	
EVC	1.44	41	2.57	3.49	4.41				l
VC	1.44	41	2.57	3.49	4.41				l
FEV1	0.92	37	1.63	2.47	3.31	1.00	40	9	l
FVC	1.44	43	2.38	3.38	4.38	1.48	44	3	l
PEF	179	42	307	426	545	163	38	-9	l/min
FEV1/VC	64								%
FEV1/FVC	64	89	68	72	84	68	94	6	%

Lung Age 90yrs
Interpretation (Nice (2010)):
Base: Obstruction.
Post1: Severe Obstruction.





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Independent interpretation…

Sex: Female Age: 82
Factor: 100(Caucasian)
Height: 152cm Weight:____kg

Turbine Transducer

(* is for auto best; ^ for manual best)

	VC	Var	Warning	Time:	Date:
Base	1.57	*	(Good blow)	16:14	22/03/16
Base	1.50	-4%	(Good blow)	16:17	22/03/16
Base	1.49	-5%	(Good blow)	16:15	22/03/16

BTS Quality Criteria (Relaxed):
Base: Met.

	FEV1	FVC	FEV1/FVC	PEF	Var	Warning	Time:
Base Date: 22/03/16							
Base	0.98	1.51	64.9	209	*	(Good blow)	16:19
Base	0.94	1.52	61.8	212	-1%	(Good blow)	16:20
Base	0.97	1.36	71.3	200	-6%	(Good blow)	16:24

Variation is based on FEV1 + FVC.

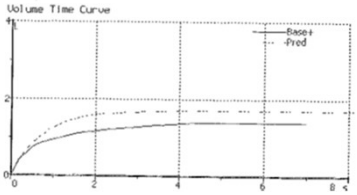
BTS Quality Criteria (Forced):
Base: Met

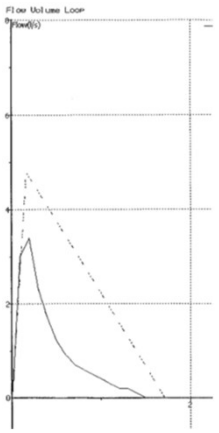
Any forced data and graphs following are either best individual values or composite curve.

Best Spirometry Result:

	Base	%Pr	Min	Normal Pred	Max	Post	%Pr	%Chg	
EVC	1.57	94	0.98	1.67	2.36				l
VC	1.57	94	0.98	1.67	2.36				l
FEV1	0.98	73	0.73	1.35	1.97				l
FVC	1.52	89	1.00	1.71	2.41				l
PEF	212	74	155	287	37[illegible]				l/min
FEV1/VC	62								%
FEV1/FVC	64	88	63	74	84				%

Lung Age 90yrs
Interpretation (Nice (2010)):
Base: Obstruction.





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Independent interpretation…

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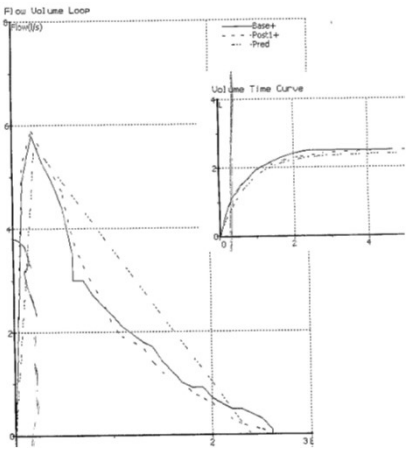


```
Sex: Female  Age: 80
Factor: 100(Caucasian)
Height: 165cm  Weight: 67kg  BMI: 24.3

Turbine Transducer

(* is for auto best: ^ for manual best)

      VC   Var     Warning              Time: Date:
Base  2.86 *       (Good blow)          15:01 12/01/16
Base  2.82 -1%     (Good blow)          15:00 12/01/16
Base  2.71 -5%     (Good blow)          14:59 12/01/16
Post1 2.86 *       (Good blow)          15:30 12/01/16
Post1 2.73 -4%     (Good blow)          15:29 12/01/16

BTS Quality Criteria (Relaxed):
Base: Met.
Post1: Not Met. Need 1 more good blow(s).

      FEV1 FVC  FEV1/FVC PEF  Var   Warning        Time:
Base Date: 12/01/16
Base  1.91 2.61 73.2      326 *     (Good blow)    15:03
Base  1.94 2.42 80.2      345 -3%   (Good blow)    15:03
Base  1.79 2.40 74.6      322 -7%   (Good blow)    15:04
Base  1.81 2.40 75.4      319 -6%   (Good blow)    15:05
Post1 Date: 12/01/16
Post1 1.69 2.32 72.8      322 -10%  (Good blow)    15:31
Post1 1.90 2.57 73.9      353 *     (Good blow)    15:32
Post1 1.69 2.29 73.8      328 -10%  (Good blow)    15:32

Variation is based on FEV1 + FVC.

BTS Quality Criteria (Forced):
Base: Not Met.  Greatest 2 FVCs differ by 190ml.
Post1: Not Met.  Greatest 2 FVCs differ by 250ml.

Any forced data and graphs following are either best
individual values or composite curve.

Best Spirometry Result:
                    !-- Normal --!!--- Post1 ---!
           Base %Pr  Min Pred Max  Post %Pr %Chg
EVC        2.86 120 1.69 2.38 3.07 2.86 120   0  1
VC         2.86 120 1.69 2.38 3.07 2.86 120   0  1
FEV1       1.94  99 1.34 1.96 2.58 1.90  97  -2  1
FVC        2.61 110 1.67 2.38 3.09 2.57 108  -2  1
PEF         345 102  248  337  426  353 105   2  l/min
FEV1/VC      68                    66        -2  %
FEV1/FVC     74 101   63   74   85   74 100  -1  %
Lung Age 80yrs
Interpretation (Nice (2010)):
Base: Normal Spirometry.
Post1: Normal Spirometry.
```

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