TOOLS TO SUPPORT DIAGNOSIS OF RESPIRATORY DISEASE

	INDICATIONS FOR USE	WHEN NOT TO USE	APPLICATION OF RESULTS IN CLINICAL PRACTICE	SPECIAL PRECAUTIONS	CARE, CLEANING, CALIBRATION
PEAK FLOW	Peak expiratory flow rate (PEFR) measures the maximum speed of expiration. It can be used to monitor asthma, and can be used to demonstrate evidence of variability in lung function when diagnosing asthma.	Peak expiratory flow rate is not relevant in COPD management.  © Tawesit / Dreamstime.com	Recorded variability of serial peak expiratory flow rate can strengthen the case for diagnosis of asthma in adults but current guidelines do not support this in children.[1] Variability can be demonstrated comparing a period when the person is symptomatic to when a person is well. It is important to establish what is 'normal' for an individual when they are well, ideally during the annual review, as a comparator to determine how unwell they have become during an exacerbation or acute attack of asthma.	Peak expiratory flow rate must be measured with a flow meter using the EU scale in the United Kingdom and all measurements for the individual patient must use the same scale. Results are user- and effort-dependent and can be influenced by incorrect technique or poor effort.	Always use a new disposable one-way valved mouthpiece for each person. If the meter is marked 'single patient use only' it must not be used for more than one patient. For cleaning and disinfecting, follow manufacturers' instructions.
SPIROMETRY	Spirometry measures the amount a person can breathe out and the time taken to do so. It is a test used to establish the person's best lung function as part of the diagnostic pathway. It can also be used to monitor chronic respiratory conditions such as COPD when it is performed annually to monitor decline in lung function.  LIFE IN VIEW/SCIENCE PHOTO LIBRARY	Do not perform spirometry if the patient has any condition that may have serious consequences by performing a forced expiration – unstable aortic aneurysm, pneumothorax or surgery within 3 months on eyes, brain, chest or abdomen. If the patient has active infection such as AFB positive for TB, do not perform spirometry until this has been treated for 2 weeks. Serious consideration needs to be given before performing spirometry if the patient has had an infection within 4–6 weeks, has undiagnosed chest symptoms such as haemoptysis, or has any condition that would be aggravated by performing forced expiration – past history (but not current) pneumothorax, myocardial infarction within a month, uncontrolled hypertension, pulmonary embolus or history of stroke, previous surgery on eyes, brain, chest or abdomen (but not within 3 months). In these cases, clinical judgement needs to be exercised in deciding the risk of undertaking the test versus the value and necessity of the results at that time.[2] If the patient is too poorly to perform spirometry it should not be performed, or if there are communication difficulties – confusion or learning difficulties, for example – and the patient cannot understand what is required of them, then spirometry will need to be delayed or abandoned.	Results need to be considered as part of a structured clinical assessment – review of medical records, history taking and physical examination – and taken in clinical context. Spirometry results can be interpreted into normal, obstructive, restrictive or mixed pattern but in isolation will not result in a diagnosis. Normal spirometry results do not rule out asthma if the patient is asymptomatic at the time of the test. Obstructive results can be seen in asthma but will be reversed to normal after administration of inhaled bronchodilator medication, or after a longer course of inhaled or oral corticosteroids. Obstructive results are seen in COPD but are not reversed to normal with medication although some improvement may be seen. Other conditions that result in obstructive spirometry results are bronchiectasis, and bronchial carcinoma will also sometimes result in an obstructive pattern. Neither of these conditions would reverse to normal with medication. Restrictive traces are seen in interstitial lung disease, pulmonary oedema, neuromuscular conditions, parenchymal tumours, obesity, pregnancy, thoracic cage deformity or following surgical excision of part or all of the lung. Mixed spirometry traces are seen in very severe COPD, advanced bronchiectasis, cystic fibrosis or a combination of respiratory disease and another condition such as osteoporosis.	Diagnosis relies on the performance of quality assured spirometry. Spirometry is very user- and operator-dependent. The introduction of the National Register of certified professionals and operators[3] seeks to address variation in care by setting national standards of performance. All healthcare professionals performing spirometry and those interpreting results should be assessed as competent in their role.  SCIENCE PHOTO LIBRARY/SCIENCE PHOTO LIBRARY	A log should be kept of cleaning procedures. Immunocompromised patients should be tested on newly disinfected equipment. A disposable one-way valved mouthpiece and disposable nose clip must be used for each patient. A delay of at least 5 minutes should be allowed between subjects to allow settling of previously aerosolised particles in the measuring device. Perform a visual inspection at the end of testing. If there is visible contamination to the flowhead or elsewhere on the device, clean and disinfect as per manufacturer's instructions. Clean and disinfect all parts of the equipment which have come into contact with patients once a week. An accuracy check should be performed using a 3 litre syringe at the beginning of each spirometry session or after every 10 patients. A biological control, using the same healthy volunteer, should be performed weekly. The spirometer and accuracy syringe should be returned to the manufacturer annually for calibration and service and a certificate obtained. All software updates and repairs should be documented.[4]
MICROSPIROMETRY	Screening for respiratory disease Annual review of established COPD 	Microspirometry is not suitable for use in diagnosis. If abnormal results are found, full diagnostic spirometry is required.	During screening, if normal results are found, MECC (Make Every Contact Count). Use as a health promotion opportunity for smoking cessation, activity, healthy diet and weight, mental health. If obstructive, refer for full diagnostic spirometry. At annual review in established COPD, if results are obstructive and as expected, use the consultation time with the patient on high value interventions – for example, smoking cessation, activity, inhaler technique. If results show accelerated decline, consider referral. If results are normal (not obstructive), review the diagnosis.	Most microspirometers do not require verification checks, therefore the accuracy cannot be guaranteed. The monitors are hand-held without a paper printout or computerised integration into medical records so transcription errors can occur.	Use a new one-way valved mouthpiece for each patient. Clean and service as per manufacturer's instructions.
CARBON MONOXIDE (CO) MONITORS	An exhaled CO level gives an indication of CO that has been inhaled in the previous 8–12 hours. This is usually due to active tobacco smoking but can also be due to passive inhalation from smoked tobacco but also other domestic and environmental sources. It is a motivational tool and a conversation starter where the cause is smoked tobacco and should always be used according to NICE when monitoring a quit smoking treatment plan. (http://www.londonsenate.nhs.uk/wp-content/uploads/2015/04/Helping-Smokers-Quit-Programme-The-expired-carbon-monoxide-CO-test.pdf	Avoid use in undiagnosed haemoptysis as an infection control measure.	A result of 0–4 ppm (parts per million) indicates the person is unlikely to have smoked in the last 24 hours. A level of 5–9 ppm suggests recent exposure to a moderate level of CO – the person may be a non-smoker or a light smoker. A reading of 10 ppm or above indicates exposure to a higher level of CO and the person is almost certainly a smoker (NICE guidelines)	None noted. 	Single use mouthpiece for each person. 6–12-monthly calibration required using CO calibration gas cylinder.
PULSE OXIMETRY	Pulse oximetry is used to assess oxygen saturation but must be used as part of a complete patient assessment, not in isolation.[5] 	Never use in the absence of any other patient assessment criteria.	**Asthma**: If oxygen saturations below 92%, consider acute admission. Aim to keep saturation 94–98% with emergency oxygen if available. **COPD**: Routine review: Saturations less than 92% at rest, especially if on more than one occasion, consider for referral for oxygen assessment. *NB: Some patients with hypercapnic respiratory failure will deteriorate if given high dose oxygen. In acute situations use pulse oximetry to maintain saturations 88–92% in those considered to be at risk.* **Acute respiratory infection**: If oxygen saturation is below 92% in a previously healthy person, consider admission.	Results affected if: • patient is poorly perfused (cold fingers/toes) – hypotension, hypovolaemia, cold environment, cardiac failure • CO poisoning (carboxyhaemaglobin) • Shivering or background movement • Nail varnish or dirty nails affecting light transmission • High artificial lighting Cardiac arrhythmias need careful interpretation. The effect of jaundice is uncertain.	Clean between patients by removing visible dirt and contamination. If disposable electrodes used, replace between patients.
FRACTION OF EXHALED NITRIC OXIDE (FENO) MONITORING	Fraction of exhaled nitric oxide monitoring (FeNO) measures the amount of nitric oxide in exhaled breath in parts per billion (ppb) in an easy to use test. Nitric oxide production in exhaled breath directly relates to eosinophilic inflammation in the airways, so the higher the FeNO result the more airway inflammation is measured. FeNO can be used as part of the diagnostic pathway for asthma[1] or asthma COPD overlap syndrome (ACOS)[6] to guide treatment decisions for stepping up or down asthma therapy, to help aid patient adherence to prescribed asthma medication, and to help aid patient education regarding asthma and the action of inhaled steroids and bronchodilators to improve supported self-management. 	After repeated spirometry manoeuvres.	0–25 ppb, not inflamed: • **Diagnosis** unlikely asthma (≤20% likelihood) • **Symptomatic asthma** check inhaler technique, triggers, adherence, increase anti-inflammatory therapy (ICS) • **Asymptomatic asthma** step down if no predictable risk 25–50 ppb, intermediate range: • **Diagnosis** revisit history and examination, possible asthma, code suspected asthma, trial of treatment (ICS) and review • **Symptomatic asthma** check inhaler technique, triggers, adherence, consider increase in anti-inflammatory therapy (ICS) • **Asymptomatic asthma** possible inflammation, check adherence and closer questioning regarding symptoms. Review 2 months or sooner if unwell 50 ppb or above, inflammation present: • **Diagnosis** asthma likely (≥80% likelihood) if history also suggestive • **Symptomatic asthma** check inhaler technique, triggers, discuss adherence, increase anti-inflammatory therapy (ICS) • **Asymptomatic asthma** inflammation is present, enquire closely about symptoms and adherence. Do not step down medication	Results can be influenced by smoking, exercise, bronchoconstriction and repeated spirometry manoeuvres (perform FeNO first) which all suppress nitric oxide production. Patients already taking ICS will also have a suppressed nitric oxide level. Respiratory tract infection, allergic rhinitis and a diet rich in nitrate foods (e.g. leafy greens, beetroot, spinach, rhubarb) will all increase nitric oxide levels.	No calibration necessary. Some monitors require a biological control test. Consumables vary between meters but are more costly than other respiratory tests listed.

	LOW	NORMAL	INTERMEDIATE	HIGH
Allergic airway inflammation	Unlikely	Unlikely	Present, but mild	Significant
ADULTS				
FeNO value (Fractional Exhaled Nitric Oxide)	<5	5-25	25-50	>50 (or a rise of >60% since previous measurement)
CHILDREN < 12 years				
FeNO value (Fractional Exhaled Nitric Oxide)	<5	5-20	20-35	>35 (or a rise of >60% since previous measurement)

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