

Asthma: diagnosis and monitoring of asthma in adults, children and young people

NICE guideline

Draft for consultation, January 2015

If you wish to comment on this version of the guideline, please be aware that all the supporting information and evidence is contained in the full version.

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Introduction

Asthma is a chronic inflammatory respiratory disease. It can affect people of any age, but often starts in childhood. It is characterised by attacks (also known as exacerbations) of breathlessness and wheezing, with the severity and frequency of attacks varying from person to person. The attacks are associated with variable airflow obstruction and inflammation within the lungs, which if left untreated can be life-threatening, however with the appropriate treatment can be reversible.

The World Health Organization estimates that 235 million people have asthma worldwide, and it is the most common chronic condition to affect children. In the UK, 4.1 million people get treatment for asthma.

The causes of asthma are not well understood. A number of risk factors are associated with the condition, often in combination. These influences can be genetic (the condition clusters in families) and/or environmental (such as inhalation of allergens or chemical irritants). Occupational causes of asthma in adults are often under-recognised.

There is currently no gold standard test available to diagnose asthma; diagnosis is principally based on a thorough history taken by an experienced clinician. It is therefore not surprising that studies of adults diagnosed with asthma suggest that up to 30% do not have clear evidence of asthma. Some may have had asthma in the past, but it is likely that many have been given an incorrect diagnosis. The typical wheeze found in a person with asthma is a continuous, polyphonic whistling sound produced in the airways during expiration and is related to obstruction of the airways on breathing out. Expiratory polyphonic wheeze is a characteristic clinical symptom and sign in people with asthma or other obstructive airways diseases.

Initial clinical assessment should include questions about symptoms (wheezing, cough, breathing and chest problems) and any personal or family history of allergies, atopic disorders or asthma. Various tests can be used to support a diagnosis, but there is no single test that can definitively diagnose asthma.

A number of methods and assessments are available to determine the likelihood of asthma. These include measuring airflow obstruction (spirometry and peak flow) and

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assessment of reversibility with bronchodilators, with both methods being widely used in current clinical practice. However, normal results do not exclude asthma and abnormal results do not always mean it is asthma, as they could be indicators of other respiratory diseases or spurious readings.

Testing for airway inflammation is increasingly used as a diagnostic strategy in clinical practice. This includes measuring fractional exhaled nitric oxide (FeNO). However, there is some uncertainty about both the sensitivity and specificity of FeNO, particularly as to whether it can distinguish general atopy from asthma.

Other diagnostic strategies include blood or skin prick tests to detect allergic reactions to environmental influences, exercise tests to detect evidence of bronchoconstriction, and measures of airway hyper-reactivity such as histamine/methacholine or mannitol challenge tests. However, it is debatable which test or measure, or combination of them, is the most effective to accurately diagnose asthma.

It is recognised that asthma control is suboptimal in many people with asthma. This has an impact on their quality of life, their use of healthcare services and the associated costs. Asthma control can be monitored by measuring airway obstruction or inflammation and by using validated questionnaires, but the most effective monitoring strategy is unclear.

The aim of this guideline is, therefore, to determine the most clinical and cost-effective way to effectively diagnose people with asthma and determine the most effective monitoring strategy to ensure optimum asthma control.

The scope of this guideline covers the diagnosis and monitoring of asthma and excludes other aspects of management. This is because there is evidence that incorrect diagnosis is a significant problem.

This guideline covers infants and young children 0–5 years old, children 5–16 years old and adults over the age of 16 who are being investigated for suspected asthma, or who have been diagnosed with asthma and are having their condition monitored. The guideline applies to all primary, secondary and community care settings in which NHS-funded care is provided for people with asthma.

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Medicine recommendations

The guideline will assume that prescribers will use a medicine's summary of product characteristics to inform decisions made with individual patients.

Patient-centred care

This guideline offers best practice advice on the care of adults, young people and children with suspected asthma or with a confirmed diagnosis of asthma.

Patients and healthcare professionals have rights and responsibilities as set out in the [NHS Constitution for England](#) – all NICE guidance is written to reflect these. Treatment and care should take into account individual needs and preferences. Patients should have the opportunity to make informed decisions about their care and treatment, in partnership with their healthcare professionals. If the patient is under 16, their family or carers should also be given information and support to help the child or young person to make decisions about their treatment. Healthcare professionals should follow the [Department of Health's advice on consent](#). If someone does not have capacity to make decisions, healthcare professionals should follow the [code of practice that accompanies the Mental Capacity Act](#) and the supplementary [code of practice on deprivation of liberty safeguards](#).

NICE has produced guidance on the components of good patient experience in adult NHS services. All healthcare professionals should follow the recommendations in [Patient experience in adult NHS services](#).

If a young person is moving between paediatric and adult services, care should be planned and managed according to the best practice guidance described in the Department of Health's [Transition: getting it right for young people](#).

Adult and paediatric healthcare teams should work jointly to provide assessment and services to young people with suspected or confirmed asthma. Diagnosis and management should be reviewed throughout the transition process, and there should be clarity about who is the lead clinician to ensure continuity of care.

Strength of recommendations

Some recommendations can be made with more certainty than others. The Guideline Development Group makes a recommendation based on the trade-off between the benefits and harms of an intervention, taking into account the quality of the underpinning evidence. For some interventions, the Guideline Development Group is confident that, given the information it has looked at, most patients would choose the intervention. The wording used in the recommendations in this guideline denotes the certainty with which the recommendation is made (the strength of the recommendation).

For all recommendations, NICE expects that there is discussion with the patient about the risks and benefits of the interventions, and their values and preferences. This discussion aims to help them to reach a fully informed decision (see also 'Patient-centred care').

Interventions that must (or must not) be used

We usually use 'must' or 'must not' only if there is a legal duty to apply the recommendation. Occasionally we use 'must' (or 'must not') if the consequences of not following the recommendation could be extremely serious or potentially life threatening.

Interventions that should (or should not) be used – a 'strong' recommendation

We use 'offer' (and similar words such as 'refer' or 'advise') when we are confident that, for the vast majority of patients, an intervention will do more good than harm, and be cost effective. We use similar forms of words (for example, 'Do not offer...') when we are confident that an intervention will not be of benefit for most patients.

Interventions that could be used

We use 'consider' when we are confident that an intervention will do more good than harm for most patients, and be cost effective, but other options may be similarly cost effective. The choice of intervention, and whether or not to have the intervention at all, is more likely to depend on the patient's values and preferences than for a strong

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recommendation, and so the healthcare professional should spend more time considering and discussing the options with the patient.

Key priorities for implementation

The following recommendations have been identified as priorities for implementation. The full list of recommendations is in [section 1](#).

Comment [LK1]: Will be linked in final published web viewer version.

Diagnosing asthma: Initial clinical assessment

- Check for suspected occupational asthma by asking employed people with newly-diagnosed asthma or established asthma that is poorly controlled:
 - are symptoms better on days away from work?
 - are symptoms better when on holiday¹?Make sure all answers are recorded for later review. **[1.1.7]**

Diagnosing asthma: Objective tests

- Use spirometry as the first-line investigation for asthma in adults and young people older than 16 and children aged 5–16 years. Regard a forced expiratory volume in 1 s/forced vital capacity (FEV₁/FVC) ratio of less than 70% as a positive test for obstructive airway disease (obstructive spirometry). See also recommendation 1.2.2. **[1.1.9]**
- Offer a bronchodilator reversibility (BDR) test to adults and young people older than 16 with obstructive spirometry (FEV₁/FVC ratio less than 70%). Regard an improvement in FEV₁ of 12% or more, together with an increase in volume of 200 ml or more, as a positive test. **[1.1.10]**
- Offer a BDR test to children aged 5–16 years with obstructive spirometry (FEV₁/FVC ratio less than 70%). Regard an improvement in FEV₁ of 12% or more as a positive test. **[1.1.11]**
- Offer a FeNO test in adults and young people older than 16 if a diagnosis of asthma is being considered. Regard a FeNO level of 40 parts per billion (ppb) or more as a positive test. **[1.1.16]**
- Offer a direct bronchial challenge test with histamine or methacholine² in adults and young people older than 16 if there is diagnostic uncertainty after a normal spirometry and either a:

¹ 'Holiday' here means any longer time away from work than usual breaks at weekends or between shifts.

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- FeNO level of 40 ppb or more and no variability in peak flow readings or
 - FeNO level of 39 ppb or less with variability in peak flow readings.
- Regard a PC20 value of 8 mg/ml or less as a positive test. [1.1.19]

Diagnosing asthma in children younger than 5 years

- Treat symptoms based on observation and clinical judgement in children younger than 5 years. If asthma is still suspected when the child is old enough to take part in objective tests (usually around the age of 5), perform these and review the diagnosis. [1.2.1]

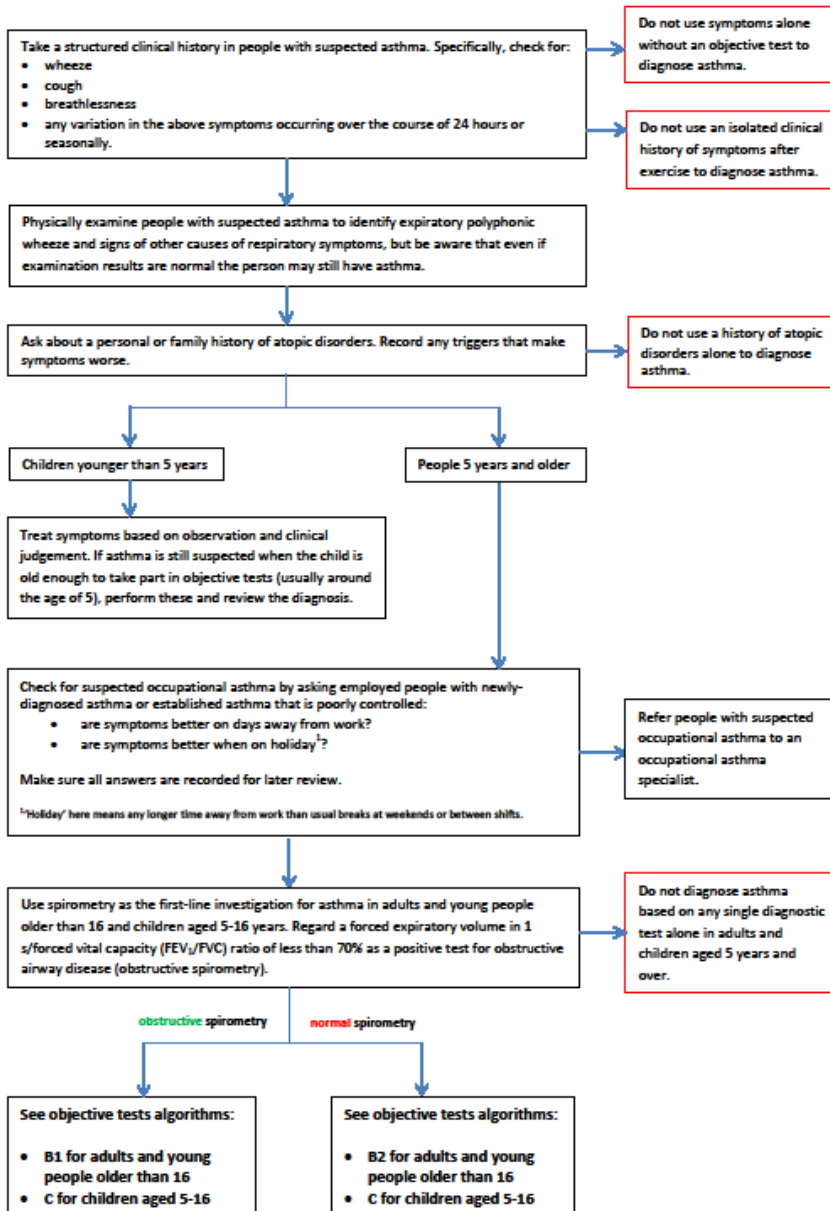
Monitoring asthma control

- Consider using a validated questionnaire (the Asthma Control Questionnaire or Asthma Control Test) to monitor asthma control in adults and young people older than 16. [1.3.2]
- Monitor asthma control at each review in adults and children aged 5 years and over using either spirometry (FEV₁) or peak flow variability. [1.3.3]
- Monitor the inhaler technique of people with asthma (in line with the [NICE quality standard on asthma](#)):
 - after every asthma attack
 - when the device is changed
 - at every annual review. [1.3.7]

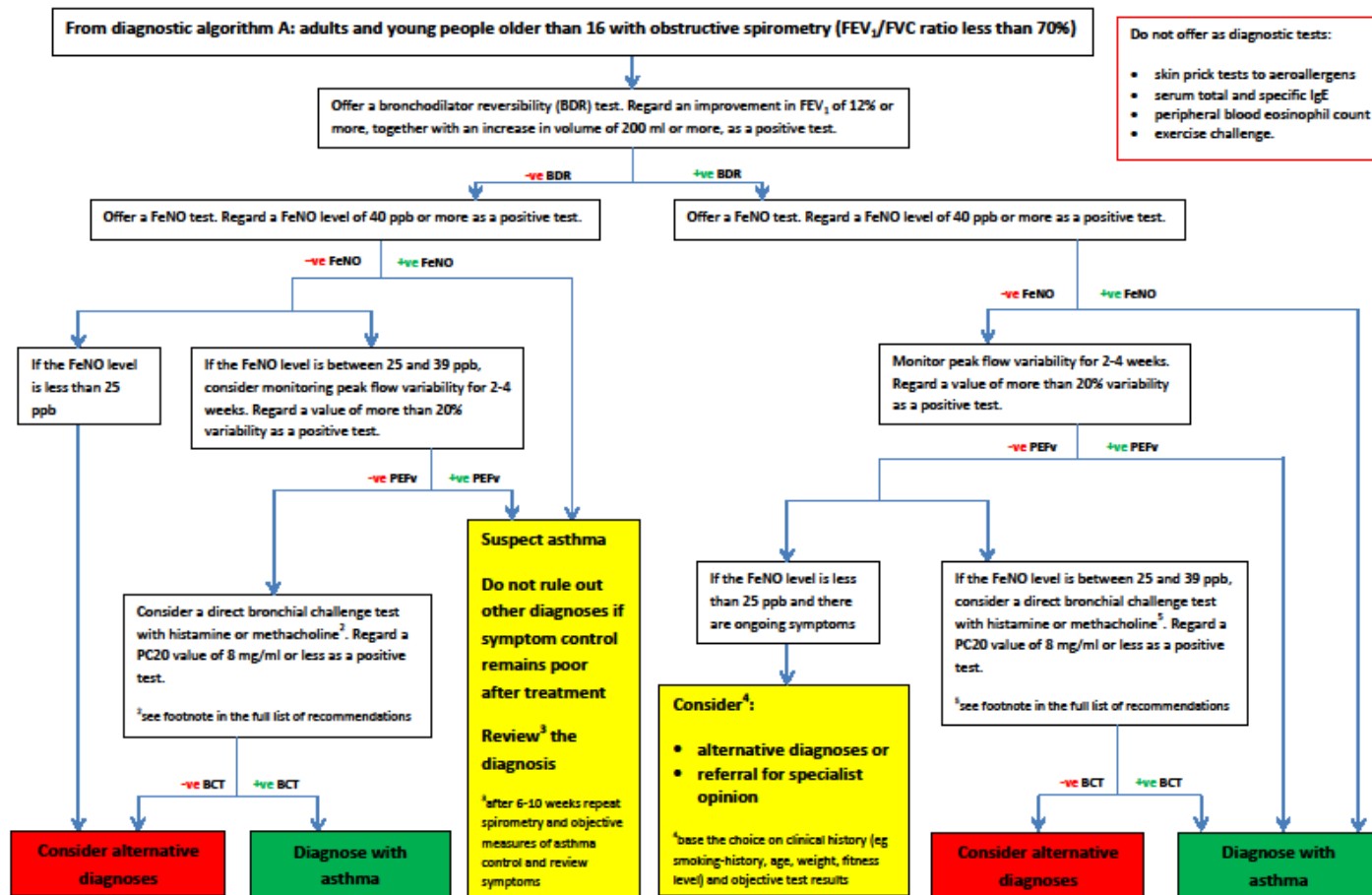
² At the time of consultation (January 2015), methacholine did not have a UK marketing authorisation for this use. The healthcare professional should follow relevant professional guidance, taking full responsibility for the decision to use this test. Informed consent should be obtained and documented. See the General Medical Council's [Prescribing guidance: prescribing unlicensed medicines](#) for further information.

Diagnostic algorithms

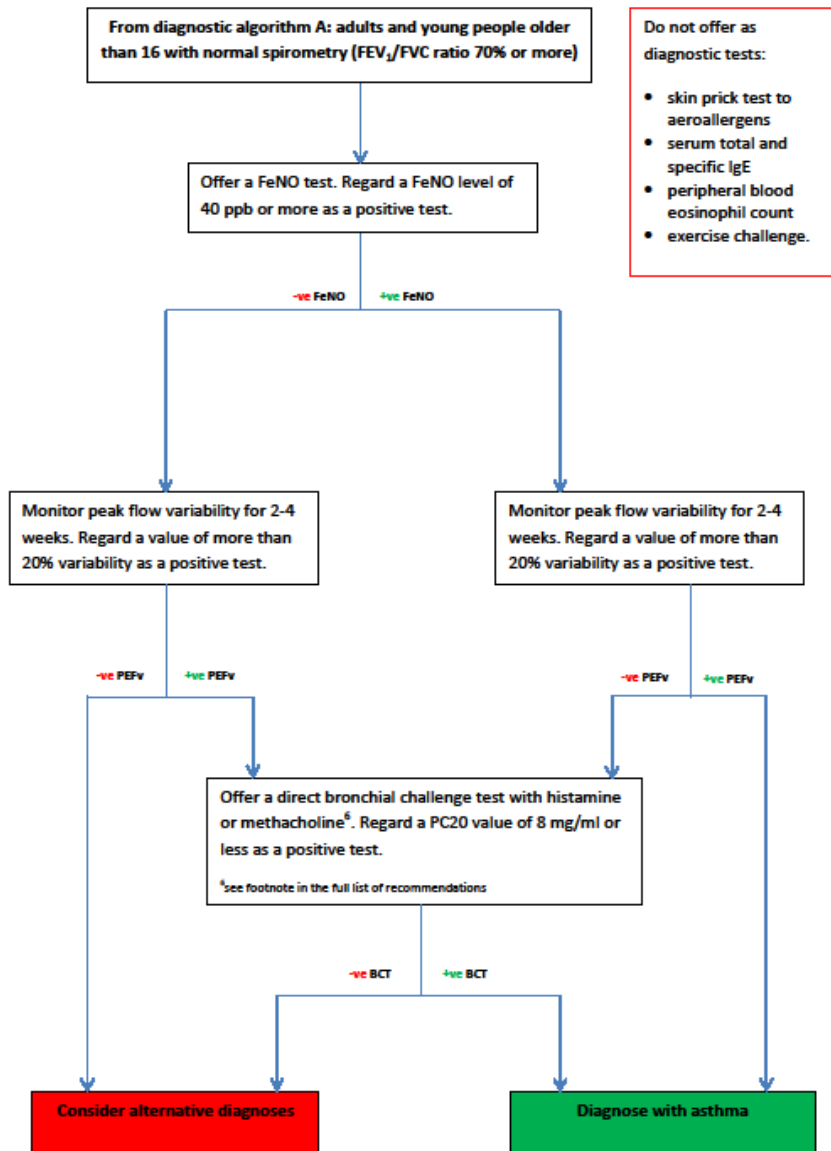
Diagnostic algorithm A – initial clinical assessment and first-line objective test for adults and children



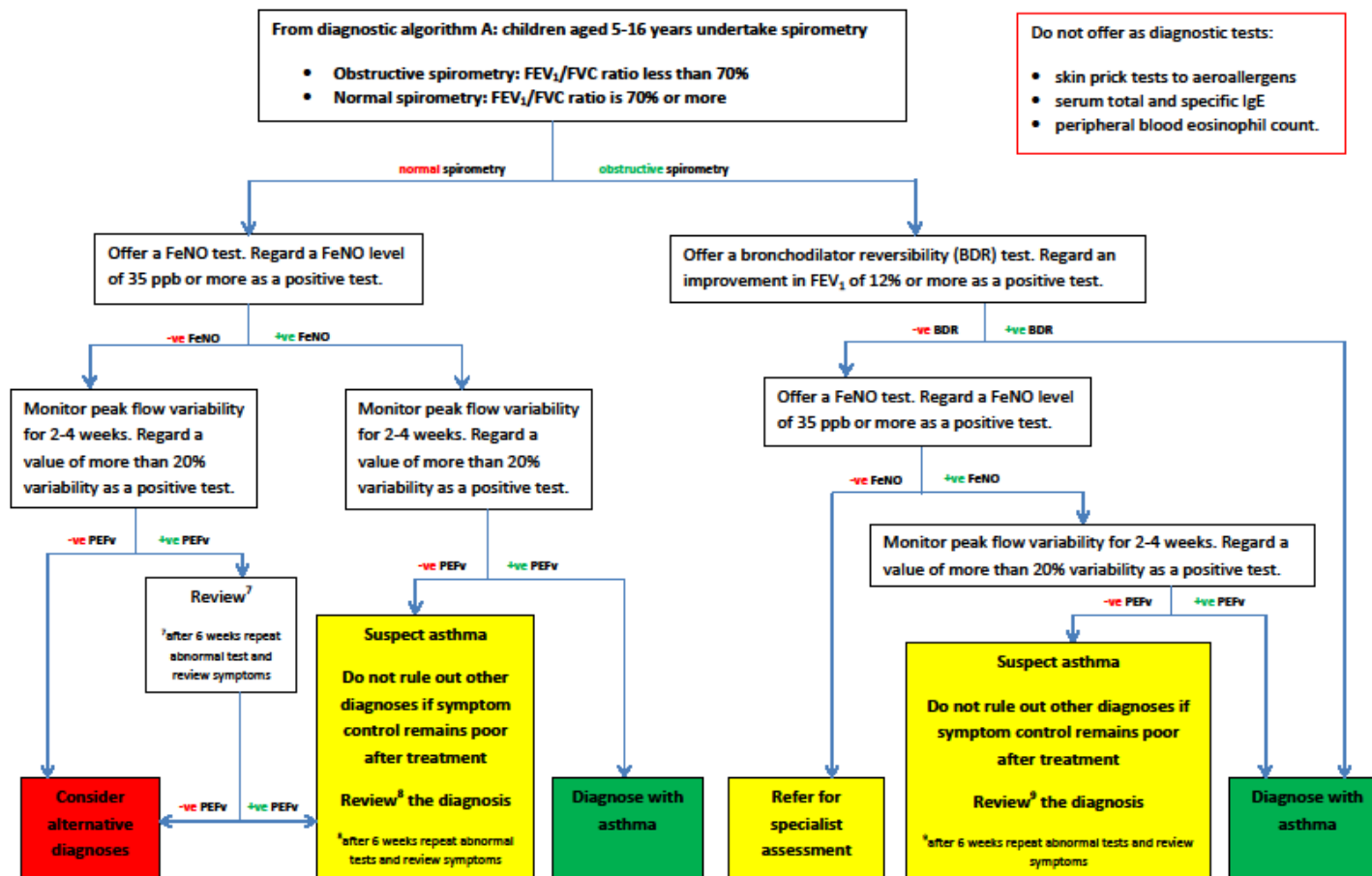
Diagnostic algorithm B1 – objective tests for adults and young people older than 16 with obstructive spirometry



Diagnostic algorithm B2 – objective tests for adults and young people older than 16 with normal spirometry



Diagnostic algorithm C – objective tests for children aged 5-16 years



1 Recommendations

The following guidance is based on the best available evidence. The [full guideline](#) [\[hyperlink to be added for final publication\]](#) gives details of the methods and the evidence used to develop the guidance.

1.1 *Diagnosing asthma*

Initial clinical assessment

Signs and symptoms

- 1.1.1 Take a structured clinical history in people with suspected asthma. Specifically, check for:
- wheeze
 - cough
 - breathlessness
 - any variation in the above symptoms occurring over the course of 24 hours or seasonally.
- 1.1.2 Do not use symptoms alone without an objective test to diagnose asthma.
- 1.1.3 Physically examine people with suspected asthma to identify expiratory polyphonic wheeze and signs of other causes of respiratory symptoms, but be aware that even if examination results are normal the person may still have asthma.

History of atopic disorders

- 1.1.4 Ask about a personal or family history of atopic disorders. Record any triggers that make symptoms worse.
- 1.1.5 Do not use a history of atopic disorders alone to diagnose asthma.

Symptoms after exercise

- 1.1.6 Do not use an isolated clinical history of symptoms after exercise to diagnose asthma.

Occupational asthma

1.1.7 Check for suspected occupational asthma by asking employed people with newly-diagnosed asthma or established asthma that is poorly controlled:

- are symptoms better on days away from work?
- are symptoms better when on holiday³?

Make sure all answers are recorded for later review.

1.1.8 Refer people with suspected occupational asthma to an occupational asthma specialist.

Objective tests

Lung function tests

Spirometry

1.1.9 Use spirometry as the first-line investigation for asthma in adults and young people older than 16 and children aged 5–16 years. Regard a forced expiratory volume in 1 s/forced vital capacity (FEV₁/FVC) ratio of less than 70% as a positive test for obstructive airway disease (obstructive spirometry). See also recommendation 1.2.2.

Bronchodilator reversibility

1.1.10 Offer a bronchodilator reversibility (BDR) test to adults and young people older than 16 with obstructive spirometry (FEV₁/FVC ratio less than 70%). Regard an improvement in FEV₁ of 12% or more, together with an increase in volume of 200 ml or more, as a positive test.

1.1.11 Offer a BDR test to children aged 5–16 years with obstructive spirometry (FEV₁/FVC ratio less than 70%). Regard an improvement in FEV₁ of 12% or more as a positive test.

³ 'Holiday' here means any longer time away from work than usual breaks at weekends or between shifts.

Peak expiratory flow variability

1.1.12 Monitor peak flow variability for 2–4 weeks in adults and young people older than 16 if there is diagnostic uncertainty after initial assessment and they have either:

- normal spirometry and the results of a fractional exhaled nitric oxide (FeNO) test or
- obstructive spirometry, reversible airways obstruction (positive BDR) and a FeNO level of 39 parts per billion (ppb) or less.

Regard a value of more than 20% variability as a positive test.

1.1.13 Consider monitoring peak flow variability for 2–4 weeks in adults and young people older than 16 if there is diagnostic uncertainty after initial assessment and they have:

- obstructive spirometry **and**
- irreversible airways obstruction (negative BDR) **and**
- a FeNO level between 25 and 39 ppb.

Regard a value of more than 20% variability as a positive test.

1.1.14 Monitor peak flow variability for 2–4 weeks in children aged 5–16 years if there is diagnostic uncertainty after initial assessment and they have either:

- normal spirometry and the results of a FeNO test or
- obstructive spirometry, irreversible airways obstruction (negative BDR) and a FeNO level of 35 ppb or more.

Regard a value of more than 20% variability as a positive test.

Allergy testing

1.1.15 Do not offer the following as diagnostic tests for asthma:

- skin prick tests to aeroallergens
- serum total and specific IgE.

Airway inflammation measures

Fractional exhaled nitric oxide

- 1.1.16 Offer a FeNO test in adults and young people older than 16 if a diagnosis of asthma is being considered. Regard a FeNO level of 40 parts per billion (ppb) or more as a positive test.
- 1.1.17 Offer a FeNO test in children aged 5–16 years if there is diagnostic uncertainty after initial assessment and they have either:
- normal spirometry or
 - obstructive spirometry with negative BDR.

Regard a FeNO level of 35 ppb or more as a positive test.

Peripheral blood eosinophil count

- 1.1.18 Do not offer a peripheral blood eosinophil count as a diagnostic test for asthma.

Airway hyper-reactivity measures

Direct bronchial challenge test with histamine or methacholine

- 1.1.19 Offer a direct bronchial challenge test with histamine or methacholine⁴ in adults and young people older than 16 if there is diagnostic uncertainty after a normal spirometry and either a:
- FeNO level of 40 ppb or more and no variability in peak flow readings or
 - FeNO level of 39 ppb or less with variability in peak flow readings.

Regard a PC20 value of 8 mg/ml or less as a positive test.

- 1.1.20 Consider a direct bronchial challenge test with histamine or methacholine⁴ in adults and young people older than 16 with:

⁴ At the time of consultation (January 2015), methacholine did not have a UK marketing authorisation for this use. The healthcare professional should follow relevant professional guidance, taking full responsibility for the decision to use this test. Informed consent should be obtained and documented. See the General Medical Council's [Prescribing guidance: prescribing unlicensed medicines](#) for further information.

- obstructive spirometry **and**
- a FeNO level between 25 and 39 ppb **and**
- no variability in peak flow readings (less than 20% variability over a 2–4 week period).

Regard a PC20 value of 8 mg/ml or less as a positive test.

Indirect bronchial challenge test with exercise

- 1.1.21 Do not offer adults and young people older than 16 an exercise challenge test as a diagnostic test for asthma.

1.2 Diagnostic summaries

These recommendations should be used together with the diagnostic algorithms and the detailed descriptions of the investigations and tests given in sections 1.1 and 1.2.

Children younger than 5 years (algorithm A)

- 1.2.1 Treat symptoms based on observation and clinical judgement in children younger than 5 years. If asthma is still suspected when the child is old enough to take part in objective tests (usually around the age of 5), perform these and review the diagnosis.

Adults and children aged 5 years and over (algorithm A)

- 1.2.2 Do not diagnose asthma based on any single diagnostic test alone in adults and children aged 5 years and over.

Adults and young people older than 16 with obstructive spirometry (algorithm B1)

- 1.2.3 Diagnose asthma in adults and young people older than 16 if they have obstructive spirometry and:
- negative bronchodilator reversibility, a FeNO level between 25 and 39 ppb, negative peak flow variability and a positive direct bronchial challenge test or
 - positive bronchodilator reversibility and a FeNO level of 40 ppb or more or

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- positive bronchodilator reversibility, a FeNO level of 39 ppb or less and positive peak flow variability test or
- positive bronchodilator reversibility, a FeNO level between 25 and 39 ppb, negative peak flow variability and a positive direct bronchial challenge test.

1.2.4 Suspect asthma in adults and young people older than 16 with obstructive spirometry, negative bronchodilator reversibility and:

- a FeNO level of 40 ppb or more or
- a FeNO level between 25 and 39 ppb and positive peak flow variability.

Do not rule out other diagnoses if symptom control continues to remain poor after treatment. Review the diagnosis after 6–10 weeks by repeating spirometry and objective measures of asthma control and reviewing symptoms.

1.2.5 In adults and young people older than 16 with obstructive spirometry, positive bronchodilator reversibility, negative peak flow variability and a FeNO level less than 25 ppb and ongoing symptoms, consider:

- alternative diagnoses or
- referral for specialist opinion.

Base the choice on the person's clinical history (for example whether they are a smoker, age, weight, how fit they are) together with their objective test results.

1.2.6 Consider alternative diagnoses in adults and young people older than 16 with obstructive spirometry and:

- negative bronchodilator reversibility and a FeNO level less than 25 ppb or
- positive bronchodilator reversibility, a FeNO level between 25 and 39 ppb, negative peak flow variability and a negative direct bronchial challenge test.

Adults and young people older than 16 with normal spirometry (algorithm B2)

- 1.2.7 Diagnose asthma in adults and young people older than 16 if they have normal spirometry and:
- a FeNO level of 40 ppb or more and positive peak flow variability or
 - a FeNO level of 40 ppb or more, negative peak flow variability and a positive direct bronchial challenge test or
 - a FeNO level of 39 ppb or less, positive peak flow variability and a positive direct bronchial challenge test.
- 1.2.8 Consider alternative diagnoses in adults and young people older than 16 if they have normal spirometry and:
- a FeNO level of 39 ppb or less and negative peak flow variability or
 - a FeNO level of 39 ppb or less, positive peak flow variability and a negative direct bronchial challenge test or
 - a FeNO level of 40 ppb or more, negative peak flow variability and a negative direct bronchial challenge test.

Children aged 5–16 (algorithm C)

- 1.2.9 Diagnose asthma in children aged 5–16 if they have:
- normal spirometry, a FeNO level of 35 ppb or more and positive peak flow variability or
 - obstructive spirometry and positive bronchodilator reversibility or
 - obstructive spirometry, negative bronchodilator reversibility, a FeNO level of 35 ppb or more and positive peak flow variability.
- 1.2.10 Refer children aged 5–16 for specialist assessment if they have obstructive spirometry, negative bronchodilator reversibility and a FeNO level of 34 ppb or less.
- 1.2.11 Suspect asthma in children aged 5–16 if they have:
- normal spirometry, a FeNO level of 35 ppb or more and negative peak flow variability or

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- obstructive spirometry, negative bronchodilator reversibility, a FeNO level of 35 ppb or more and negative peak flow variability or
- normal spirometry, a FeNO level of 34 ppb or less and positive peak flow variability confirmed by a retest after 6 weeks.

Do not rule out other diagnoses if symptom control continues to remain poor after treatment. Review the diagnosis after 6 weeks by repeating any abnormal tests and reviewing symptoms.

1.2.12 Consider alternative diagnoses in children aged 5–16 if they have normal spirometry, a FeNO level of 34 ppb or less and:

- negative peak flow variability or
- positive peak flow variability that is negative on retest after 6 weeks.

1.3 *Monitoring asthma control*

1.3.1 Monitor asthma control at every review.

1.3.2 Consider using a validated questionnaire (the Asthma Control Questionnaire or Asthma Control Test) to monitor asthma control in adults and young people older than 16.

1.3.3 Monitor asthma control at each review in adults and children aged 5 years and over using either spirometry (FEV₁) or peak flow variability.

1.3.4 Do not routinely use FeNO to monitor asthma control.

1.3.5 Consider FeNO measurement as an option to support asthma management in people who are symptomatic despite using inhaled corticosteroids [This recommendation is from [Measuring fractional exhaled nitric oxide concentration in asthma](#) (DG12)] [2014].

1.3.6 Do not use challenge testing to monitor asthma control.

1.3.7 Monitor the inhaler technique of people with asthma (in line with the [NICE quality standard on asthma](#)):

- after every asthma attack

- when the device is changed
- at every annual review.

2 Implementation: getting started

NICE has worked with the guideline development group to identify areas in the draft guideline that may have a big impact on practice or could be challenging to implement. The draft guideline recommends that a diagnosis of asthma in adults and children over 5 years should not be based on the results of any single diagnostic test or spirometry alone. In relation to this, if the draft recommendations are not changed after consultation we think that the 3 most important and challenging areas to implement will be:

- using spirometry [recommendations 1.2.1, 1.2.2]
- FeNO challenge testing [recommendations 1.2.9, 1.2.10]
- bronchial challenge testing [recommendations 1.2.12, 1.2.13].

During consultation we want stakeholders to let us know if you agree with these choices, or if you would give priority to other areas. We would also like you to send us suggestions of ways that these challenges could be addressed – such as by sharing examples of good practice, or by letting us know about existing educational materials or other resources. This information will be used to write an implementation section for the final guideline.

Please send us your comments and suggestions using the comments form.

Factors affecting implementation

Spirometry

Spirometry equipment is already available and in use in primary care. It is mainly used to diagnose chronic obstructive pulmonary disease (COPD). Although it is cost effective, it is not usually used to help diagnose asthma as the benefits of doing so may not be well known by GPs. At present, when it is used there may be variation in investigation standards and the subsequent interpretation of results.

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Using spirometry in children aged 5–16 years is a significant change in practice and will be practically challenging if a child does not want or is unable to cooperate. Healthcare professionals using this investigation will need to develop the knowledge and skills to use it effectively with children, and encourage children to cooperate with them.

Also, primary care professionals may need to improve their skills in interpreting spirometry results for both adults and children, so that they are better informed when deciding the next step in the diagnosis pathway or identifying what medication to offer.

FeNO challenge testing

FeNO challenge testing has only recently been introduced in primary care, and the availability of FeNO testing equipment is patchy. A business case aimed at those responsible for commissioning and assessing the testing will need to be developed to support investment in new equipment and to provide education and training in its use for primary care professionals.

Bronchial challenge testing

The recommendations on bronchial challenge testing [recommendations 1.2.12, 1.2.13] are a significant change to the diagnostic pathway. This test is only usually available in secondary and tertiary care, and it is likely only a few primary care professionals will have access to it at present. Adding this test to the new diagnostic pathway will mean that people eligible to be offered it can be referred by primary care professionals. It is important that healthcare professionals with this new referral responsibility are aware of the benefits of the test and its place in the new diagnostic pathway, in order to ensure appropriate referral and effective diagnosis. Implementation of these recommendations is likely to increase referrals for this test. Commissioners and trusts will need to work together to respond to this change in referral pathways and increased demand in a cost-effective way.

3 Research recommendations

The Guideline Development Group has made the following recommendations for research, based on its review of evidence, to improve NICE guidance and patient

care in the future. The Guideline Development Group's full set of research recommendations is detailed in the full guideline.

3.1 *Diagnosing asthma in children aged 5–16 years*

What is the acceptability and diagnostic accuracy of objective tests that could be used to comprise a diagnostic pathway for asthma in children aged 5–16 years old (for example, exercise challenge, direct bronchial challenge with histamine or methacholine, indirect bronchial challenge with mannitol and peripheral blood eosinophil count)?

Why this is important

Asthma is a common condition, diagnosed in nearly 1 in 10 children. There are no validated and reliable objective criteria for diagnosing asthma, so the vast majority of asthma diagnoses are currently based on symptoms and signs. However, symptoms and signs consistent with a diagnosis of asthma are not specific to the condition and can be present in other illnesses. This diagnostic uncertainty results in many children being incorrectly diagnosed with asthma, and many children with asthma in whom the diagnosis is delayed or missed. A single objective measure, or set of objective measures, that can be performed easily in non-specialist clinical settings (although it is noted that challenge tests need to be performed in specialist settings) will help improve diagnostic certainty and reduce the proportion of children treated inappropriately for asthma. This would ensure that children with the condition are identified and treated early.

3.2 *Diagnosing asthma in adults and young people older than 16*

What is the clinical and cost effectiveness of using an indirect bronchial challenge test with mannitol to diagnose asthma in adults and young people older than 16?

Why this is important

Chronic airway inflammation is associated with bronchial hyper-responsiveness, which is integral to defining asthma. Bronchial challenge testing can help diagnose asthma and assess response to inhaled corticosteroid therapy. It can also be used to

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monitor asthma control, alongside assessing symptoms and lung function. It is increasingly used in asthma management, although currently most tests are performed only in specialised centres or research settings.

Indirect challenge tests with inhaled mannitol act via active inflammatory cells and mediators, whereas direct challenge tests with inhaled histamine or methacholine act directly on bronchial smooth muscle. Indirect challenge testing is more specific but less sensitive than direct challenges.

Direct challenge testing may not identify a person who will respond to inhaled steroids. A positive result to an indirect challenge may reflect active airway inflammation that is likely to respond to inhaled corticosteroid therapy. Because a response to mannitol indicates active airway inflammation, identifying non-responsiveness in treated patients may help demonstrate good asthma control with inhaled corticosteroid therapy and identify people less likely to deteriorate after a dose reduction.

Mannitol bronchial challenge testing is quicker and simpler than current direct tests (which are generally confined to specialist respiratory centres), and uses a standardised inhaler device, so is potentially more useful in primary care.

3.3 *Monitoring adherence to treatment*

What is the clinical and cost effectiveness of using electronic alert systems designed to monitor and improve adherence with regular inhaled maintenance therapy in people with asthma?

Why this is important

Adherence with regular maintenance inhaled corticosteroids, on their own or in combination with long-acting beta agonists, is of paramount importance to achieve control of asthma and prevent asthma attacks. Published evidence in patients with severe asthma suggests that at least 30% of patients are partially or non-adherent with their prescribed medications, and the Royal College of Physicians' National

Review of Asthma Deaths (NRAD)⁵ demonstrated that poor adherence was associated with 38% of asthma deaths.

3.4 *Monitoring inhaler technique*

What is the current frequency and the current method being used to check the inhaler technique of people with asthma? What is the optimal frequency and the best method of checking inhaler technique to improve clinical outcomes for people with asthma?

Why this is important

Knowing and understanding how to use an inhaler properly is the cornerstone of asthma management and symptom control. There has been an increase in the types of inhaler devices and the types of delivery system available. The various types of drugs for asthma control are also available in different inhaler devices on their own and in a combination of 2 drugs. It is therefore vital for patients to learn the proper inhaler technique for their device to ensure optimum drug delivery to the lungs for asthma control.

3.5 *Monitoring asthma control using tele-healthcare*

What is the long-term (more than 12 months) clinical and cost effectiveness of using tele-healthcare as a means to monitor asthma control in children, young people and adults? Modalities of tele-healthcare can include telephone interview (healthcare professional involvement) and internet or smartphone-based monitoring support (no healthcare professional involvement).

Why this is important

Asthma outcomes have not improved in the past 15 years, and the personal and economic costs of poor control are high. Computers and smartphones play an ever-greater role in modern life, with a growing proportion of people using them regularly for work, leisure, communication and information. The efficient use of distance monitoring systems and the integration of new technologies into healthcare are

⁵ Royal College of Physicians' [National Review of Asthma Deaths](#) (May 2014).

important for patients and for healthcare systems in terms of convenience, costs and outcomes.

4 Other information

4.1 Scope and how this guideline was developed

NICE guidelines are developed in accordance with a [scope](#) that defines what the guideline will and will not cover.

How this guideline was developed

NICE commissioned the National Clinical Guideline Centre to develop this guideline. The Centre established a Guideline Development Group (see section 4), which reviewed the evidence and developed the recommendations.

The methods and processes for developing NICE clinical guidelines are described in [The guidelines manual](#).

4.2 Related NICE guidance

Details are correct at the time of consultation on the guideline (January 2015).

Further information is available on [the NICE website](#).

Published

General

- [Patient experience in adult NHS services](#). NICE guidance CG138 (2012).

Condition-specific

- [Measuring fractional exhaled nitric oxide concentration in asthma: NIOX MINO, NIOX VERO and NObreath](#) NICE diagnostics guidance 12 (2014).
- [Quality standard for asthma](#) NICE quality standard 25 (2013).
- [Omalizumab for the treatment of severe persistent allergic asthma in children aged 6 and over and adults](#) NICE technology appraisal guidance 278 (2013).

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- [Roflumilast for the management of severe chronic obstructive pulmonary disease](#) NICE technology appraisal guidance 244 (2012).
- [Bronchial thermoplasty for severe asthma](#) NICE interventional procedure guidance 419 (2012).
- [Chronic obstructive pulmonary disease](#) NICE guideline CG101 (2009).
- [Respiratory tract infections](#) NICE guideline CG69 (2008).
- [Inhaled corticosteroids for the treatment of chronic asthma in adults and in children aged 12 years and over](#) NICE technology appraisal guidance 138 (2008).
- [Inhaled corticosteroids for the treatment of chronic asthma in children under the age of 12 years](#) NICE technology appraisal guidance 131 (2007).
- [Inhaler devices for routine treatment of chronic asthma in older children \(aged 5–15 years\)](#) NICE technology appraisal guidance 38 (2002).
- [Guidance on the use of inhaler systems \(devices\) in children under the age of 5 years with chronic asthma](#) NICE technology appraisal guidance 10 (2000).

Under development

NICE is developing the following guidance:

- [Bronchiolitis in children](#) NICE guideline. Publication expected May 2015.

5 The Guideline Development Group, National Collaborating Centre and NICE project team

5.1 Guideline Development Group

John Alexander

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Tara Burn

Patient member

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Val Hudson

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Matthew Masoli

Consultant Respiratory Physician, Plymouth Hospitals NHS Trust

Melanie McFeeters

Consultant Nurse for Children's Respiratory Diseases, University Hospitals of Leicester NHS Trust

Andrew Menzies-Gow (GDG Chair)

Consultant Respiratory Physician, Royal Brompton & Harefield NHS Foundation Trust

Georgina Russell

RCP Clinical Fellow (specialist trainee adviser) (until January 2014)

Tahmina Siddiqui

GP Partner, Whaddon Medical Centre, Milton Keynes

Michael Thomas

Professor of Primary Care Research, University of Southampton

5.2 National Clinical Guideline Centre

Emily Davies

Senior Research Fellow (from September 2013)

Elisabetta Fenu

Senior Health Economist (until November 2013 and from September 2014)

Alexander Haines

Health Economist (from October 2013)

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Bernard Higgins

Clinical Director

Emma Madden

Research Fellow (from June 2014)

Paul Miller

Senior Information Scientist (until September 2014)

Rachel O'Mahony

Senior Research Fellow (until May 2014)

Jill Parnham

Operations Director (until September 2014)

Amelia Unsworth

Project Manager (from November 2013)

Giulia Zuodar

Document Editor and Process Assistant (from June 2014)

5.3 NICE project team

Sarah Willett

Guideline Lead

Martin Allaby

Clinical Adviser

Caroline Keir

Guideline Commissioning Manager

Margaret Ghلامي

Guideline Coordinator

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David Glynn

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Gareth Haman

Editor

5.4 *Declarations of interests*

The following members of the Guideline Development Group made declarations of interests. All other members of the Group stated that they had no interests to declare.

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Member	Interest declared	Type of interest	Decision taken
John Alexander	Paid by GlaxoSmithKline for lecture to GPs	Non-specific personal pecuniary	Declare and participate
John Alexander	Paid by Abbvie for lecture on RSV	Non-specific personal pecuniary	Declare and participate
John Alexander	Paid by Abbvie for advisory board on preventing RSV admissions.	Non-specific personal pecuniary	Declare and participate
Erol Gaillard	Research grant from Novartis	Non-specific non-personal pecuniary	Declare and participate
Erol Gaillard	Member of the BTS/SIGN Asthma Guideline Development Group	Personal non-pecuniary	Declare and participate
Erol Gaillard	Research collaboration with MedImmune a biotech firm with links to AstraZeneca	Personal non-pecuniary	Declare and participate
Ren Gilmartin	Paid honoraria by Teva for position on "Integrated Care advisory board"	Non-specific personal pecuniary	Declare and participate
Ren Gilmartin	Paid honoraria by British Lung Foundation for development of "Train the Trainer COPD and Self Management" programme	Non-specific personal pecuniary	Declare and participate
Ren Gilmartin	PCRS-UK executive and PCRS-UK Nurse committee and received loss of earnings payment plus travel expenses	Non-specific personal pecuniary	Declare and participate
Ren Gilmartin	Fee from British Lung Foundation for providing COPD training to GPs and nurses in Hertfordshire	Non-specific personal pecuniary	Declare and participate
Ren Gilmartin	Honoraria received from TEVA for attending advisory meeting	Non-specific personal pecuniary	Declare and participate
Ren Gilmartin	Honoraria received from Almirall for attending nurse group meeting	Non-specific personal pecuniary	Declare and participate
Ren Gilmartin	Fee from RTA training for asthma update presentation for school nurses	Non-specific personal pecuniary	Declare and participate
Val Hudson	My husband was commissioned by North Durham Clinical Commissioning Group (in shadow form) to carry out a piece of work on developing public and patient involvement in the CCG	Personal family interest	Declare and participate
Val Hudson	I attended a Boehringer Ingelheim	Reasonable	Declare and

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	training event for their medical and marketing staff in Berlin. The company wanted their staff to understand what it was like for someone 'living with asthma.' I was interviewed by a GP and we both then fielded questions from the audience. The session lasted one hour. I received accommodation and travel expenses but no other reimbursements	travel expenses	participate
Matthew Masoli	Received support from GlaxoSmithKline to attend the EACCI conference and with Novartis for the ERS annual conference. Support included registration and accommodation	Non-specific personal pecuniary	Declare and participate
Matthew Masoli	Paid by GlaxoSmithKline to do a talk on 'asthma control' as part of an allergy study day for GP's and practice nurses	Non-specific personal pecuniary	Declare and participate
Matthew Masoli	Speaker fee for an educational talk and workshop to healthcare professionals on 'reducing emergency asthma admissions' for a severe asthma study day sponsored by Novartis	Non-specific personal pecuniary	Declare and participate
Matthew Masoli	Spoken presentation at a severe asthma symposium sponsored by Novartis	Non-specific personal pecuniary	Declare and participate
Melanie McFeeters	Received speaker fees, expenses and hospitality from the pharmaceutical industry for both speaking & attending meetings that have taken place in the last 12 months and which are planned but have not taken place yet. This includes receiving fees for presenting educational talks to other Healthcare Professionals and hospitality for attending meetings and conferences related to the diagnosis and management of asthma. The companies include Abbott, Abbvie, AstraZeneca, GlaxoSmithKline, Novartis, Roche & Schering Plough	Non-specific personal pecuniary	Declare and participate
Melanie McFeeters	Member of the British Thoracic Society (BTS) and committee member of the BTS Nurse Advisory Group	Personal non-pecuniary	Declare and participate

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Melanie McFeeters	Member of the BTS/SIGN 101 British Guideline on the Management of Asthma Guideline Development Group – Organisation and Delivery of Care	Personal non-pecuniary	Declare and participate
Melanie McFeeters	Speaker fee received for educational talk to healthcare professionals. Meeting sponsored by GSK. Talk presented - Asthma management in children	Non-specific personal pecuniary	Declare and participate
Melanie McFeeters	Steering committee/Advisory board meeting attended on 3/2/14 for AbbVie in preparation for the EMBRACE 2014 meeting – Prophylaxis for RSV	Non-specific personal pecuniary	Declare and participate
Andrew Menzies-Gow (GDG Chair)	Received payment for attending advisory boards for Roche, NAPP, Boehringer Ingelheim and Novartis	Non-specific personal pecuniary	Declare and participate
Andrew Menzies-Gow (GDG Chair)	Received lecture fees for presenting and chairing education meetings from Novartis, Glaxo SmithKline and NAPP	Non-specific personal pecuniary	Declare and participate
Andrew Menzies-Gow (GDG Chair)	Royal Brompton and Harefield NHS Foundation Trust has received payment for participation in phase II and III studies on severe asthma where I am the principal investigator from GlaxoSmithKline, Novartis and Roche	Non-specific non-personal pecuniary	Declare and participate
Andrew Menzies-Gow (GDG Chair)	Current grant from Asthma UK	Non-specific non-personal pecuniary	Declare and participate
Andrew Menzies-Gow (GDG Chair)	Member of the BTS severe asthma network and BTS asthma SAG	Personal non-pecuniary	Declare and participate
Andrew Menzies-Gow (GDG Chair)	Resigned my position on the BTS/SIGN asthma guidelines	n/a	Declare and participate
Andrew Menzies-Gow (GDG Chair)	Payment for advisory board attendance for Amgen who are trialling a novel monoclonal antibody for use in severe asthma	Non-specific personal pecuniary	Declare and participate
Andrew Menzies-Gow (GDG Chair)	Attended advisory boards for Roche on Lebrikizumab in severe asthma	Non-specific personal pecuniary	Declare and participate
Andrew Menzies-Gow (GDG Chair)	Presented on specialist commissioning of severe asthma at 4 meetings for Novartis	Non-specific personal pecuniary	Declare and participate
Andrew	Presented at 2 meetings in	Non-specific	Declare and

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Menzies-Gow (GDG Chair)	Denmark on severe asthma for Novartis	personal pecuniary	participate
Andrew Menzies-Gow (GDG Chair)	Attended Gulf Thoracic Society in UAE, sponsored by Novartis	Non-specific personal pecuniary	Declare and participate
Andrew Menzies-Gow (GDG Chair)	Two presentations to primary care on the use of Flutiform in asthma, sponsored by NAPP	Non-specific personal pecuniary	Declare and participate
Andrew Menzies-Gow (GDG Chair)	One presentation on specialist commissioning of severe asthma services sponsored by Novartis	Non-specific personal pecuniary	Declare and participate
Andrew Menzies-Gow (GDG Chair)	Attended one advisory board for Boehringer Ingelheim discussing the use of Tiotropium in severe asthma	Non-specific personal pecuniary	Declare and participate
Andrew Menzies-Gow (GDG Chair)	Received lecture fees from NAPP for talking about the use of Flutiform in asthma	Non-specific personal pecuniary	Declare and participate
Andrew Menzies-Gow (GDG Chair)	Received lecture fees from GlaxoSmithKline for talking about Real Life clinical trials and the Salford Lung Study	Non-specific personal pecuniary	Declare and participate
Andrew Menzies-Gow (GDG Chair)	Received lecture fees from Chiesi for talking about the Management of Severe Asthma	Non-specific personal pecuniary	Declare and participate
Andrew Menzies-Gow (GDG Chair)	Filming for Boehringer Ingelheim on the use of Tiotropium in severe asthma	Non-specific personal pecuniary	Declare and participate
Andrew Menzies-Gow (GDG Chair)	Lecture fees for a presentation on severe asthma for Boehringer Ingelheim	Non-specific personal pecuniary	Declare and participate
Andrew Menzies-Gow (GDG Chair)	Lecture fees for a pro con debate on severe asthma for Novartis	Non-specific personal pecuniary	Declare and participate
Andrew Menzies-Gow (GDG Chair)	Lecture fees for a presentation on treatment options for severe asthma and severe asthma workshop for severe asthma for Boehringer-Ingelheim	Non-specific personal pecuniary	Declare and participate
Tahmina Siddiqui	Member of iCOPD template development group in conjunction with PCRS UK, funded by Kendle Healthcare	Non-specific personal non-pecuniary	Declare and participate
Tahmina Siddiqui	Attended ERS in September 2102, also to attend a iCOPD meeting funded by Kendle Healthcare	Non-specific personal pecuniary	Declare and participate
Tahmina Siddiqui	Lead GP for COPD in Milton Keynes	Non-specific personal non-pecuniary	Declare and participate

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Tahmina Siddiqui	Long term intervention team (LIT) chairperson Milton Keynes	Non-specific personal non-pecuniary	Declare and participate
Tahmina Siddiqui	Chaired a GP study day COPD Master class on September 2013 sponsored by Almiral	Non-specific personal pecuniary	Declare and participate
Tahmina Siddiqui	Attended 1st COPD world Summit conference in Lisbon sponsored by Almiral	Non-specific personal pecuniary	Declare and participate
Mike Thomas	Received honoraria for attending advisory panels from the following companies manufacturing respiratory products in the last 12 months: GlaxoSmithKline; Almiral; Novartis	Non-specific personal pecuniary	Declare and participate
Mike Thomas	Received sponsorship to attend the European Respiratory Society meeting from Napp	Non-specific personal pecuniary	Declare and participate
Mike Thomas	Research study funded by GSK	Non-specific non-personal pecuniary	Declare and participate
Mike Thomas	Received an honorarium for speaking at the ERS at the Aerocrine sponsored symposium	Specific personal pecuniary	Declare and withdraw for FeNO
Mike Thomas	Received speaker's honoraria for speaking at sponsored meetings from the following companies marketing respiratory and allergy products: Aerocrine; Astra Zeneca; Boehringer Ingelheim; GSK; MSD; Napp; Schering-Plough; Teva	Specific personal pecuniary	Declare and withdraw for FeNO
Mike Thomas	Received honoraria for attending advisory panels with; Aerocrine, Almiral, Astra Zeneca, BI, Chiesi, GSK, MSD, Merck Respiratory, Schering-Plough, Teva, Novartis	Specific personal pecuniary	Declare and withdraw for FeNO
Mike Thomas	Received sponsorship to attend international scientific meetings from: GSK, MSD, Astra Zeneca, Mundipharma	Non-specific personal pecuniary	Declare and participate
Mike Thomas	Received funding for research projects from: GSK, Almiral	Non-specific non-personal pecuniary	Declare and participate
Mike Thomas	Chief medical adviser to the charity Asthma UK, a member of the BTS SIGN Asthma guideline group. He is a member of the EPOS Rhinosinusitis guideline group	Personal non-pecuniary	Declare and participate
Mike Thomas	Spoken at the ERS on the use of	Personal	Declare and

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	exhaled nitric oxide in the diagnosis and management of asthma and spoke to the NICE team on this topic as an expert witness	non-pecuniary	participate
Mike Thomas	My department has received an honorarium for me speaking at the ERS at the Aerocrine sponsored symposium and my department has received honoraria for me attending an advisory board and for giving a talk at a GP educational meeting	Specific non-personal pecuniary	Declare and withdraw for FeNO but can answer questions on request by the Chair
Mike Thomas	My department has received honoraria for producing a research study protocol for Novartis	Non-specific non-personal pecuniary	Declare and participate
Mike Thomas	My department has received an honorarium from Aerocrine (makers of a FENO monitor) for my attendance at an advisory meeting to discuss research needs in the FENO evidence and we are discussing a possible Horizon 2020 grant application for a multinational collaborative EU-Industry funded project	Specific non-personal pecuniary	Declare and withdraw for FeNO but can answer questions on request by the Chair
Mike Thomas	My department has received funding from GSK as I am the Chief Investigator and chair of the steering committee of an international study investigating inhaler device errors	Non-specific non-personal pecuniary	Declare and participate
Mike Thomas	Received an honorarium from Boehringer Ingelheim for attendance at a meeting organising a collaborative project with the University of Nottingham/PRIMIS to create an asthma electronic audit tool for use in general practice, and from Novartis for speaking at meeting on COPD	Non-specific personal pecuniary	Declare and participate