Healthcare Improvement Scotland

SIGN
Scottish Intercollegiate Guidelines Network

101

British Guideline on the Management of Asthma

A national clinical guideline

May 2008

Revised January 2012

KEY TO EVIDENCE STATEMENTS AND GRADES OF RECOMMENDATIONS

LEVELS OF EVIDENCE	
1^{++}	High quality meta-analyses, systematic reviews of RCTs, or RCTs with a very low risk of bias
1^{+}	Well conducted meta-analyses, systematic reviews, or RCTs with a low risk of bias
1^{-}	Meta-analyses, systematic reviews, or RCTs with a high risk of bias
2^{++}	High quality systematic reviews of case control or cohort studies High quality case control or cohort studies with a very low risk of confounding or bias and a high probability that the relationship is causal
2^{+}	Well conducted case control or cohort studies with a low risk of confounding or bias and a moderate probability that the relationship is causal
2^{-}	Case control or cohort studies with a high risk of confounding or bias and a significant risk that the relationship is not causal
3	Non-analytic studies, eg case reports, case series
4	Expert opinion

GRADES OF RECOMMENDATION	
Note: The grade of recommendation relates to the strength of the evidence on which the recommendation is based. It does not reflect the clinical importance of the recommendation.	
A	At least one meta-analysis, systematic review, or RCT rated as 1^{++}, and directly applicable to the target population; or A body of evidence consisting principally of studies rated as 1^{+}, directly applicable to the target population, and demonstrating overall consistency of results
B	A body of evidence including studies rated as 2^{++}, directly applicable to the target population, and demonstrating overall consistency of results; *or* Extrapolated evidence from studies rated as 1^{++} or 1^{+}
C	A body of evidence including studies rated as 2^{+}, directly applicable to the target population and demonstrating overall consistency of results; *or* Extrapolated evidence from studies rated as 2^{++}
D	Evidence level 3 or 4; or Extrapolated evidence from studies rated as 2^{+}

GOOD PRACTICE POINTS	
☑	Recommended best practice based on the clinical experience of the guideline development group
❖	Audit point

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1 Introduction

1.1 THE NEED FOR A GUIDELINE

Asthma is a common condition which produces a significant workload for general practice, hospital outpatient clinics and inpatient admissions. It is clear that much of this morbidity relates to poor management particularly the under use of preventative medicine.

In 1999 the British Thoracic Society (BTS) and the Scottish Intercollegiate Guidelines Network (SIGN) agreed to jointly produce a comprehensive new asthma guideline, both having previously published guidance on asthma. The original BTS guideline dated back to 1990 and the SIGN guidelines to 1996. Both organisations recognised the need to develop the new guideline using explicitly evidence based methodology. The joint process was further strengthened by collaboration with Asthma UK, the Royal College of Physicians of London, the Royal College of Paediatrics and Child Health, the General Practice Airways Group (now Primary Care Respiratory Society UK), and the British Association of Accident and Emergency Medicine (now the College of Emergency Medicine). The outcome of these efforts was the British Guideline on the Management of Asthma published in 2003.[1]

The 2003 guideline was developed using SIGN methodology.[2] Electronic literature searches extended to 1995, although some sections required searches back as far as 1966. The pharmacological management section utilised the North of England Asthma guideline to address some of the key questions on adult management.[3] The North of England guideline literature search covered a period from 1984 to December 1997, and SIGN augmented this with a search from 1997 onwards.

1.1.1 UPDATING THE EVIDENCE

Since 2003 sections within the guideline have been updated annually and posted on both the BTS (www.brit-thoracic.org.uk) and SIGN (www.sign.ac.uk) websites.

The timescale of the literature search for each section is given in Annex 1. It is hoped that this asthma guideline continues to serve as a basis for high quality management of both acute and chronic asthma and a stimulus for research into areas of management for which there is little evidence. Sections of the guideline will continue to be updated on the BTS and SIGN websites on an annual basis.

1.2 REMIT OF THE GUIDELINE

1.2.1 OVERALL OBJECTIVES

This guideline provides recommendations based on current evidence for best practice in the management of asthma. It makes recommendations on management of adults, including pregnant women, adolescents, and children with asthma. In sections 4 and 5 on pharmacological management and inhaler devices respectively, each recommendation has been graded and the supporting evidence assessed for adults and adolescents over 12 years old, children 5-12 years, and children under 5 years. In section 7.1 recommendations are made on managing asthma in adolescents (10-19 years of ages as defined by the World Health Organisation (WHO).[864]

The guideline considers asthma management in all patients with a diagnosis of asthma irrespective of age or gender (although there is less available evidence for people at either age extreme). The guideline does not cover patients whose primary diagnosis is not asthma, for example those with chronic obstructive pulmonary disease or cystic fibrosis, but patients with these conditions can also have asthma. Under these circumstances many of the principles set out this guideline will apply to the management of their asthma symptoms.

The key questions on which the guideline is based can be found on the SIGN website, **www.sign.ac.uk**, as part of the supporting material for this guideline.

1.2.2 TARGET USERS OF THE GUIDELINE

This guideline will be of interest to healthcare professionals involved in the care of people with asthma. The target users are, however, much broader than this, and include people with asthma, their parents/carers and those who interact with people with asthma outside of the NHS, such as teachers. It will also be of interest to those planning the delivery of services in the NHS in England, Wales, Northern Ireland and Scotland.

1.2.3 SUMMARY OF UPDATES TO THE GUIDELINE, BY SECTION

2	Diagnosis	2008, 2011
3	Non-pharmacological management	2008,
4	Pharmacological management	2004, 2005, 2006, 2008, 2009, 2011
5	Inhaler devices	2005
6	Management of acute asthma	2004,2009
7	Special situations	2004, 2008, 2009, 2011
8	Organisation and delivery of care, and audit	2008,
9	Patient education and self management	2004, 2008

In 2004 the sections on pharmacological management, acute asthma and patient self management and compliance were revised. In 2005 sections on pharmacological management, inhaler devices, outcomes and audit and asthma in pregnancy were updated, and occupational asthma was rewritten with help from the British Occupational Health Research Foundation.

In 2006 the pharmacological management section was again updated. While the web-based alterations appeared successful, it was felt an appropriate time to consider producing a new paper-based version in which to consolidate the various yearly updates. In addition, since 2006, the guideline has had input from colleagues from Australia and New Zealand.

The 2008 guideline considered literature published up to March 2007. It contains a completely rewritten section on diagnosis for both adults and children; a section on special situations which includes occupational asthma, asthma in pregnancy and the new topic of difficult asthma; updated sections on pharmacological and non-pharmacological management; and amalgamated sections on patient education and compliance, and on organisation of care and audit.

The 2009 revisions include updates to pharmacological management, the management of acute asthma and asthma in pregnancy. Update searches were conducted on inhaler devices but there was insufficient new evidence to change the existing recommendations. The annexes have also been amended to reflect current evidence.

The 2011 revisions include updates to monitoring asthma and pharmacological management, and a new section on asthma in adolescents.

1.3 STATEMENT OF INTENT

This guideline is not intended to be construed or to serve as a standard of care. Standards of care are determined on the basis of all clinical data available for an individual case and are subject to change as scientific knowledge and technology advance and patterns of care evolve. Adherence to guideline recommendations will not ensure a successful outcome in every case, nor should they be construed as including all proper methods of care or excluding other acceptable methods of care aimed at the same results. The ultimate judgement must be made by the appropriate healthcare professional(s) responsible for clinical decisions regarding a particular clinical procedure or treatment plan. This judgement should only be arrived at following discussion of the options with the patient, covering the diagnostic and treatment choices available. It is advised, however, that significant departures from the national guideline or any local guidelines derived from it should be fully documented in the patient's case notes at the time the relevant decision is taken.

1.3.1 PATIENT VERSION

Patient versions of this guideline are available from the SIGN website, **www.sign.ac.uk**.

1.3.2 PRESCRIBING OF LICENSED MEDICINES OUTWITH THEIR MARKETING AUTHORISATION

Recommendations within this guideline are based on the best clinical evidence. Some recommendations may be for medicines prescribed outwith the marketing authorisation (product licence). This is known as 'off label' use. It is not unusual for medicines to be prescribed outwith their product licence and this can be necessary for a variety of reasons.

Generally the unlicensed use of medicines becomes necessary if the clinical need cannot be met by licensed medicines; such use should be supported by appropriate evidence and experience.[947]

Medicines may be prescribed outwith their product licence in the following circumstances:

- for an indication not specified within the marketing authorisation
- for administration via a different route
- for administration of a different dose.

"Prescribing medicines outside the recommendations of their marketing authorisation alters (and probably increases) the prescribers' professional responsibility and potential liability. The prescriber should be able to justify and feel competent in using such medicines."[947]

Any practitioner following a recommendation and prescribing a licensed medicine outwith the product licence needs to be aware that they are responsible for this decision, and in the event of adverse outcomes, may be required to justify the actions that they have taken.

Prior to prescribing, the licensing status of a medication should be checked in the most recent version of the British National Formulary (BNF).[947] The summary of product characteristics (SPC) should also be consulted in the electronic medicines compendium (www.medicines.org.uk).

1.3.3 ADDITIONAL ADVICE ON THE USE OF NEW AND EXISTING MEDICINES AND TREATMENTS

The National Institute for Health and Clinical Excellence (NICE) develops multiple (MTA) and single (STA) technology appraisals that make recommendations on the use of new and existing medicines and treatments within the NHS in England and Wales. Healthcare Improvement Scotland processes MTAs for NHSScotland.

STAs are not applicable to NHSScotland. The Scottish Medicines Consortium (SMC) provides advice to NHS Boards and their Area Drug and Therapeutics Committees about the status of all newly licensed medicines and any major new indications for established products.

Practitioners should be aware of this additional advice on medicines and treatments recommended in this guideline and that recommendations made by these organisations and restrictions on their use may differ between England and Wales and Scotland.

2 Diagnosis

The diagnosis of asthma is a clinical one; there is no standardised definition of the type, severity or frequency of symptoms, nor of the findings on investigation. The absence of a gold standard definition means that it is not possible to make clear evidence based recommendations on how to make a diagnosis of asthma.

Central to all definitions is the presence of symptoms (more than one of wheeze, breathlessness, chest tightness, cough) and of variable airflow obstruction. More recent descriptions of asthma in children and in adults have included airway hyper-responsiveness and airway inflammation as components of the disease. How these features relate to each other, how they are best measured and how they contribute to the clinical manifestations of asthma, remains unclear.

Although there are many shared features in the diagnosis of asthma in children and in adults there are also important differences. The differential diagnosis, the natural history of wheezing illnesses, the ability to perform certain investigations and their diagnostic value, are all influenced by age.

2.1 DIAGNOSIS IN CHILDREN

Asthma in children causes recurrent respiratory symptoms of:

- wheezing
- cough
- difficulty breathing
- chest tightness.

Wheezing is one of a number of respiratory noises that occur in children. Parents often use "wheezing" as a non-specific label to describe any abnormal respiratory noise. It is important to distinguish wheezing – a continuous, high-pitched musical sound coming from the chest – from other respiratory noises, such as stridor or rattly breathing.[4]

There are many different causes of wheeze in childhood and different clinical patterns of wheezing can be recognised in children. In general, these patterns ("phenotypes") have been assigned retrospectively. They cannot reliably be distinguished when an individual child first presents with wheezing. In an individual child the pattern of symptoms may change as they grow older.

The commonest clinical pattern, especially in pre-school children and infants, is episodes of wheezing, cough and difficulty breathing associated with viral upper respiratory infections (colds), with no persisting symptoms. Most of these children will stop having recurrent chest symptoms by school age.

A minority of those who wheeze with viral infections in early life will go on to develop wheezing with other triggers so that they develop symptoms between acute episodes (interval symptoms) similar to older children with classical atopic asthma.[5-9] 2++

Children who have persisting or interval symptoms are most likely to benefit from therapeutic interventions.

2.1.1 MAKING A DIAGNOSIS IN CHILDREN

Initial clinical assessment

The diagnosis of asthma in children is based on recognising a characteristic pattern of episodic respiratory symptoms and signs *(see Table 1)* in the absence of an alternative explanation for them *(see Tables 2 and 3)*.

Table 1: Clinical features that increase the probability of asthma

More than one of the following symptoms: wheeze, cough, difficulty breathing, chest tightness, particularly if these symptoms:

- ◊ are frequent and recurrent[10-13]
- ◊ are worse at night and in the early morning[11,12,14]
- ◊ occur in response to, or are worse after, exercise or other triggers, such as exposure to pets, cold or damp air, or with emotions or laughter
- ◊ occur apart from colds[10]

- Personal history of atopic disorder[10,13,15]
- Family history of atopic disorder and/or asthma[10,16]
- Widespread wheeze heard on auscultation
- History of improvement in symptoms or lung function in response to adequate therapy

Table 2: Clinical features that lower the probability of asthma

- Symptoms with colds only, with no interval symptoms[10]
- Isolated cough in the absence of wheeze or difficulty breathing[17]
- History of moist cough[18]
- Prominent dizziness, light-headedness, peripheral tingling
- Repeatedly normal physical examination of chest when symptomatic
- Normal peak expiratory flow (PEF) or spirometry when symptomatic
- No response to a trial of asthma therapy[19]
- Clinical features pointing to alternative diagnosis *(see Table 3)*

Several factors are associated with a high (or low) risk of developing persisting wheezing or asthma through childhood.[15,20] The presence of these factors increases the probability that a child with respiratory symptoms will have asthma.

These factors include:

Age at presentation

The natural history of wheeze is dependent on age at first presentation. In general, the earlier the onset of wheeze, the better the prognosis. Cohort studies show a "break point" at around two years; most children who present before this age become asymptomatic by mid-childhood.[6,8,9,21] Co-existent atopy is a risk factor for persistence of wheeze independent of age of presentation. | 2^{++}

Sex

Male sex is a risk factor for asthma in pre-pubertal children. Female sex is a risk factor for the persistence of asthma in the transition from childhood to adulthood.[22,23] Boys with asthma are more likely to "grow out" of their asthma during adolescence than girls.[10,21,22,24-37]

Severity and frequency of previous wheezing episodes

Frequent or severe episodes of wheezing in childhood are associated with recurrent wheeze that persists into adolescence.[5,8,13,16,21,26,38,39] | 2^{++}

Coexistence of atopic disease

A history of other atopic conditions such as eczema and rhinitis increases the probability of asthma. Positive tests for atopy in a wheezing child also increase the likelihood of asthma. A raised specific IgE to wheat, egg white, or inhalant allergens such as house dust mite and cat dander, predicts later childhood asthma.[40,41] 2++

Other markers of allergic disease at presentation, such as positive skin prick tests and a raised blood eosinophil count, are related to the severity of current asthma and persistence through childhood.

Family history of atopy

A family history of atopy is the most clearly defined risk factor for atopy and asthma in children. The strongest association is with maternal atopy, which is an important risk factor for the childhood onset of asthma and for recurrent wheezing that persists throughout childhood.[6,34,37,42,43] 2++

Abnormal lung function

Persistent reductions in baseline airway function and increased airway responsiveness during childhood are associated with having asthma in adult life.[23] 3

Table 3: Clinical clues to alternative diagnoses in wheezy children (features not commonly found in children with asthma)

Perinatal and family history	**Possible diagnosis**
Symptoms present from birth or perinatal lung problem	Cystic fibrosis; chronic lung disease of prematurity; ciliary dyskinesia; developmental anomaly
Family history of unusual chest disease	Cystic fibrosis; neuromuscular disorder
Severe upper respiratory tract disease	Defect of host defence; ciliary dyskinesia
Symptoms and signs	
Persistent moist cough[18]	Cystic fibrosis; bronchiectasis; protracted bronchitis; recurrent aspiration; host defence disorder; ciliary dyskinesia
Excessive vomiting	Gastro-oesophageal reflux (± aspiration)
Dysphagia	Swallowing problems (± aspiration)
Breathlessness with light-headedness and peripheral tingling	Hyperventilation/panic attacks
Inspiratory stridor	Tracheal or laryngeal disorder
Abnormal voice or cry	Laryngeal problem
Focal signs in chest	Developmental anomaly; post-infective syndrome; bronchiectasis; tuberculosis
Finger clubbing	Cystic fibrosis; bronchiectasis
Failure to thrive	Cystic fibrosis; host defence disorder; gastro-oesophageal reflux
Investigations	
Focal or persistent radiological changes	Developmental anomaly; cystic fibrosis; post-infective disorder; recurrent aspiration; inhaled foreign body; bronchiectasis; tuberculosis

Case detection studies have used symptom questionnaires to screen for asthma in school-age children. A small number of questions - about current symptoms, their relation to exercise and their occurrence at night has been sufficient to detect asthma relatively efficiently.[11,12,14,44] The addition of spirometry[11,44] or bronchial hyper-responsiveness testing[45] to these questionnaires adds little to making a diagnosis of asthma in children. 2+

B **Focus the initial assessment in children suspected of having asthma on:**
- **presence of key features in the history and examination**
- **careful consideration of alternative diagnoses.**

☑ Record the basis on which a diagnosis of asthma is suspected.

2.1.2 ASSESSING THE PROBABLITY OF A DIAGNOSIS OF ASTHMA

Based on the initial clinical assessment it should be possible to determine the probability of a diagnosis of asthma.

With a thorough history and examination, an individual child can usually be classed into one of three groups *(see Figure 1):*

- **high probability** – diagnosis of asthma likely
- **low probability** – diagnosis other than asthma likely
- **intermediate probability** – diagnosis uncertain.

2.1.3 HIGH PROBABILITY OF ASTHMA

In children with a high probability of asthma based on the initial assessment, move straight to a diagnostic trial of treatment. The initial choice of treatment will be based on an assessment of the degree of asthma severity *(see section 4)*.

The clinical response to treatment should be reassessed within 2-3 months. In this group, reserve more detailed investigations for those whose response to treatment is poor or those with severe disease.[19]

☑ In children with a high probability of asthma:
- start a trial of treatment
- review and assess response
- reserve further testing for those with a poor response.

2.1.4 LOW PROBABILITY OF ASTHMA

Where symptoms, signs or initial investigations suggest that a diagnosis of asthma is unlikely, *(see Table 2)*, or they point to an alternative diagnosis *(see Table 3)*, consider further investigations. This may require referral for specialist assessment *(see Table 4)*.

Reconsider a diagnosis of asthma in those who do not respond to specific treatments.

☑ In children with a low probability of asthma, consider more detailed investigation and specialist referral.

2.1.5 INTERMEDIATE PROBABILITY OF ASTHMA

In some children, and particularly those below the age of four to five, there is insufficient evidence at the first consultation to make a firm diagnosis of asthma, but no features to suggest an alternative diagnosis. There are several possible approaches to reaching a diagnosis in this group. Which approach is taken will be influenced by the frequency and severity of the symptoms.

These approaches include:

Watchful waiting with review

In children with mild, intermittent wheeze and other respiratory symptoms which occur only with viral upper respiratory infections (colds), it is often reasonable to give no specific treatment and to plan a review of the child after an interval agreed with the parents/carers.

Trial of treatment with review

The choice of treatment (for example, inhaled bronchodilators or corticosteroids) depends on the severity and frequency of symptoms. Although a trial of therapy with inhaled or oral corticosteroids is widely used to help make a diagnosis of asthma, there is little objective evidence to support this approach in children with recurrent wheeze.

It can be difficult to assess the response to treatment as an improvement in symptoms or lung function may be due to spontaneous remission. If it is unclear whether a child has improved, careful observation during a trial of withdrawing the treatment may clarify whether a response to asthma therapy has occurred.

Spirometry and reversibility testing

In children, as in adults, tests of airflow obstruction, airway responsiveness and airway inflammation may provide support for a diagnosis of asthma.[12,44] However, normal results on testing, especially if performed when the child is asymptomatic, do not exclude a diagnosis of asthma.[46] Abnormal results may be seen in children with other respiratory diseases. Measuring lung function in young children is difficult and requires techniques which are not widely available. 2+

Above five years of age, conventional lung function testing is possible in most children in most settings. This includes measures of airway obstruction (spirometry and peak flow), reversibility with bronchodilators, and airway hyper-responsiveness.

The relationship between asthma symptoms and lung function tests including bronchodilator reversibility is complex. Asthma severity classified by symptoms and use of medicines correlates poorly with single measurements of forced expiratory volume in one second (FEV_1) and other spirometric indices: FEV_1 is often normal in children with persistent asthma.[46,47] Serial measures of peak flow variability and FEV_1 show poor concordance with disease activity and do not reliably rule the diagnosis of asthma in or out.[47] Measures of gas trapping (residual volume and the ratio of residual volume to total lung capacity, RV/TLC) may be superior to measurements of expiratory flow at detecting airways obstruction especially in asymptomatic children.[46,48] 2+

A significant increase in FEV_1 (>12% from baseline)[49] or PEF after bronchodilator indicates reversible airflow obstruction and supports the diagnosis of asthma. It is also predictive of a good response to inhaled corticosteroids.[50] However, an absent response to bronchodilators does not exclude asthma.[51] 2+ 3

Between 2-5 years of age, many children can perform several newer lung function tests that do not rely on their cooperation or the ability to perform a forced expiratory manoeuvre. In general, these tests have not been evaluated as diagnostic tests for asthma. There is often substantial overlap between the values in children with and without asthma.[52] Of the tests available, specific airways resistance (sRaw), impulse oscillometry (IOS), and measurements of residual volume (RV) appear the most promising.[53] While some of these tests have been useful in research, their role in clinical practice is uncertain.[48,53,54] Most have only been used in specialist centres and are not widely available elsewhere. It is often not practical to measure variable airway obstruction in children below the age of five. 2+

2.1.6 CHILDREN WITH AN INTERMEDIATE PROBABILITY OF ASTHMA AND EVIDENCE OF AIRWAY OBSTRUCTION

Asthma is the by far the commonest cause of airways obstruction on spirometry in children. Obstruction due to other disorders, or due to multiple causes, is much less common in children than in adults. Spirometry and other lung function tests, including tests of PEF variability,[47] lung volumes and airway responsiveness,[45] are poor at discriminating between children with asthma and those with obstruction due to other conditions.

☑ In children with an intermediate probability of asthma who can perform spirometry and have evidence of airways obstruction, assess the change in FEV_1 or PEF in response to an inhaled bronchodilator (reversibility) and/or the response to a trial of treatment for a specified period:

- if there is significant reversibility, or if a treatment trial is beneficial, a diagnosis of asthma is probable. Continue to treat as asthma, but aim to find the minimum effective dose of therapy. At a later point, consider a trial of reduction or withdrawal of treatment.
- if there is no significant reversibility, and a treatment trial is not beneficial, consider tests for alternative conditions *(see Table 3)*.

2.1.7 CHILDREN WITH AN INTERMEDIATE PROBABILITY OF ASTHMA WITHOUT EVIDENCE OF AIRWAY OBSTRUCTION

In this group, further investigations, including assessment of atopic status and bronchodilator responsiveness and if possible tests of airway responsiveness, should be considered *(see section 2.2.1)*. This is particularly so if there has been a poor response to a trial of treatment or if symptoms are severe. In these circumstances, referral for specialist assessment is indicated.

C **In children with an intermediate probability of asthma who can perform spirometry and have no evidence of airways obstruction:**

- **consider testing for atopic status, bronchodilator reversibility and, if possible, bronchial hyper-responsiveness using methacholine, exercise or mannitol.**
- **consider specialist referral.**

2.1.8 CHILDREN WITH AN INTERMEDIATE PROBABILITY OF ASTHMA WHO CANNOT PERFORM SPIROMETRY

Most children under five years and some older children cannot perform spirometry. In these children, offer a trial of treatment for a specific period. If there is clear evidence of clinical improvement, the treatment should be continued and they should be regarded as having asthma (it may be appropriate to consider a trial of withdrawal of treatment at a later stage). If the treatment trial is not beneficial, then consider tests for alternative conditions and referral for specialist assessment.

☑ In children with an intermediate probability of asthma who cannot perform spirometry, offer a trial of treatment for a specified period:

- if treatment is beneficial, treat as asthma and arrange a review
- if treatment is not beneficial, stop asthma treatment and consider tests for alternative conditions and specialist referral.

2.2 OTHER INVESTIGATIONS

2.2.1 TESTS OF AIRWAY HYPER-RESPONSIVENESS

The role of tests of airway responsiveness (airway hyper-reactivity) in the diagnosis of childhood asthma is unclear.[45,55] For example, a methacholine challenge test has a much lower sensitivity than symptoms in diagnosing asthma in children and only marginally increases the diagnostic accuracy after the symptom history is taken into account.[45] However, a negative methacholine test in children, which has a high negative predictive value, makes a diagnosis of asthma improbable.[55] Similarly, a negative response to an exercise challenge test is helpful in excluding asthma in children with exercise related breathlessness.[56] 3

2.2.2 TEST OF EOSINOPHILIC AIRWAY INFLAMMATION

Eosinophilic inflammation in children can be assessed non-invasively using induced sputum differential eosinophil count or exhaled nitric oxide concentrations (FE_{NO}).

Sputum induction is feasible in school age children.[57,58] Higher sputum eosinophil counts are associated with more marked airways obstruction and reversibility, greater asthma severity and atopy.[59] In children with newly diagnosed mild asthma, sputum eosinophilia is present and declines with inhaled steroid treatment.[58] Sputum induction is possible in approximately 75% of children tested, but it is technically demanding and time consuming and at present remains a research tool. 2^{++}

It is feasible to measure FE_{NO} in unsedated children from the age of 3-4 years.[60] A raised FE_{NO} is neither a sensitive nor a specific marker of asthma with overlap with children who do not have asthma.[61] FE_{NO} is closely linked with atopic status, age and height.[62,63] In some studies, FE_{NO} correlated better with atopic dermatitis and allergic rhinitis than with asthma. It is not closely linked with underlying lung function. FE_{NO} could not differentiate between groups once atopy was taken into account.[64] Home measurements of FE_{NO} have a highly variable relationship with other measures of disease activity and vary widely from day to day.[65] 2^{+}

At present, there is insufficient evidence to support a role for markers of eosinophilic inflammation in the diagnosis of asthma in children. They may have a role in assessing severity of disease or response to treatment.

2.2.3 TESTS OF ATOPY

Positive skin tests,[66] blood eosinophilia $\geq 4\%$[10], or a raised specific IgE to cat, dog or mite,[67,68] increase the probability of asthma in a child with wheeze, particularly in children over five years of age.[66] It is important to recognise that non-atopic wheezing is as frequent as atopic wheezing in school-age children.[69] 2^{++}

2.2.4 CHEST X-RAY

A study in primary care in children age 0-6 years concluded that a chest X-ray (CXR), in the absence of a clinical indication, need not be part of the initial diagnostic work up.[70]

☑ Reserve chest X-rays for children with severe disease or clinical clues suggesting other conditions.

2.3 SUMMARY

Focus the initial assessment of children suspected of having asthma on:

- presence of key features in the history and clinical examination
- careful consideration of alternative diagnoses.

Record the basis on which the diagnosis of asthma is suspected.

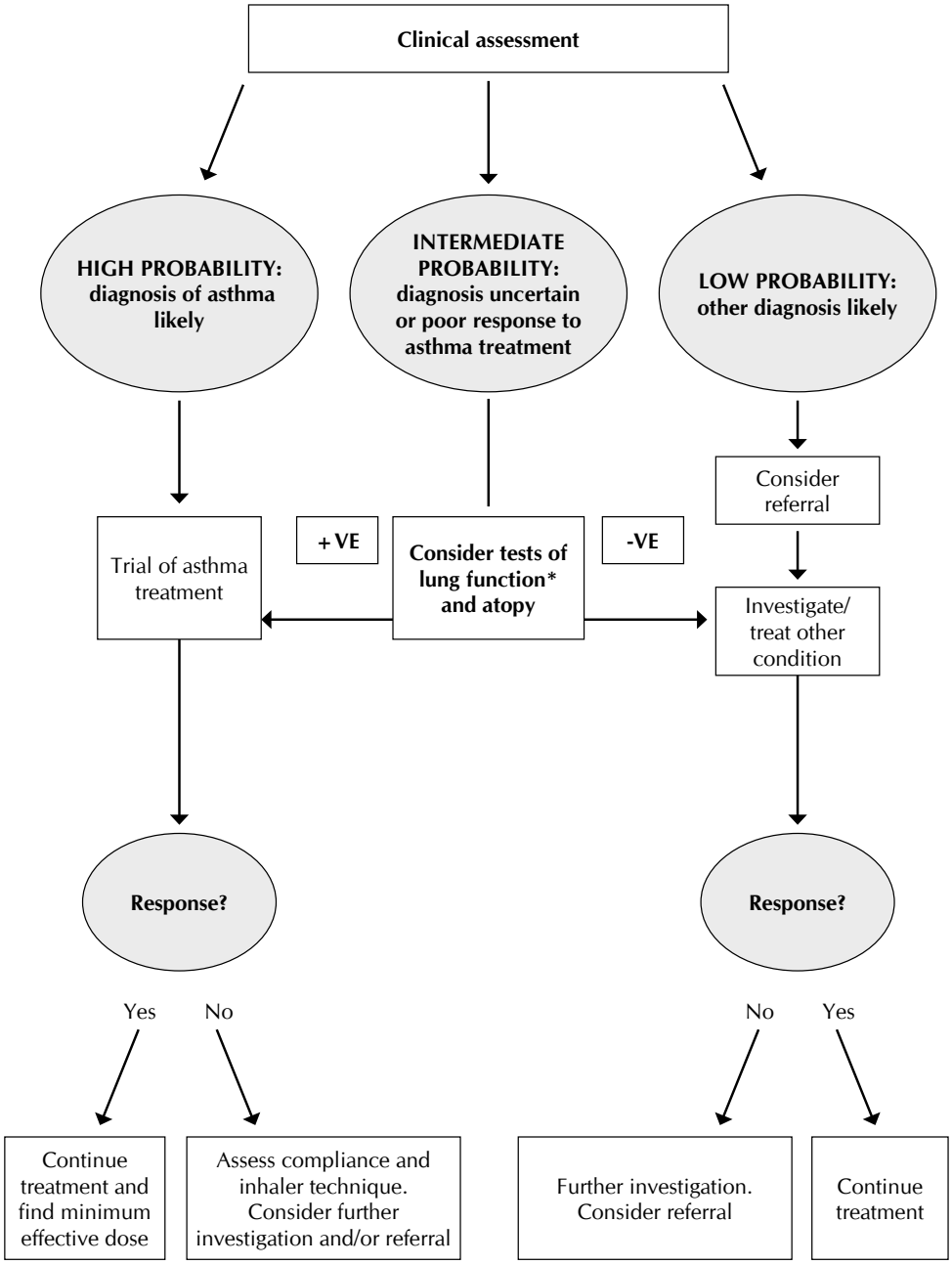
Using a structured questionnaire may produce a more standardised approach to the recording of presenting clinical features and the basis for a diagnosis of asthma.

1. **In children with a high probability of asthma:**
   - move straight to a trial of treatment
   - reserve further testing for those with a poor response.
2. **In children with a low probability of asthma:**
   - consider more detailed investigation and specialist referral.
3. **In children with an intermediate probability of asthma who can perform spirometry and have evidence of airways obstruction, offer a reversibility test and/or a trial of treatment for a specified period:**
   - if there is reversibility, or if treatment is beneficial, treat as asthma
   - if there is insignificant reversibility, and/or treatment trial is not beneficial, consider tests for alternative conditions.
4. **In children with an intermediate probability of asthma who can perform spirometry, and have no evidence of airways obstruction, consider testing for atopic status, bronchodilator reversibility and, if possible, bronchial hyper-responsiveness using methacholine or exercise.**
5. **In children with an intermediate probability of asthma, who cannot perform spirometry, consider testing for atopic status and offering a trial of treatment for a specified period:**
   - if treatment is beneficial, treat as asthma
   - if treatment is not beneficial, stop asthma treatment, and consider tests for alternative conditions and specialist referral.

Table 4: Indications for specialist referral in children

▪ Diagnosis unclear or in doubt
▪ Symptoms present from birth or perinatal lung problem
▪ Excessive vomiting or posseting
▪ Severe upper respiratory tract infection
▪ Persistent wet or productive cough
▪ Family history of unusual chest disease
▪ Failure to thrive
▪ Nasal polyps
▪ Unexpected clinical findings eg focal signs, abnormal voice or cry, dysphagia, inspiratory stridor
▪ Failure to respond to conventional treatment (particularly inhaled corticosteroids above 400 mcg/day or frequent use of steroid tablets)
▪ Parental anxiety or need for reassurance

Figure 1: Presentation with suspected asthma in children



* *Lung function tests include spirometry before and after bronchodilator (test of airway reversibility) and possible exercise or methacholine challenge (tests of airway responsiveness).*
Most children over the age of 5 years can perform lung function tests.

2.4 DIAGNOSIS IN ADULTS

The diagnosis of asthma is based on the recognition of a characteristic pattern of symptoms and signs and the absence of an alternative explanation for them *(see Table 5)*. The key is to take a careful clinical history. In many cases this will allow a reasonably certain diagnosis of asthma, or an alternative diagnosis, to be made. If asthma does appear likely, the history should also explore possible causes, particularly occupational.

In view of the potential requirement for treatment over many years, it is important even in relatively clear cut cases, to try to obtain objective support for the diagnosis. Whether or not this should happen before starting treatment depends on the certainty of the initial diagnosis and the severity of presenting symptoms. Repeated assessment and measurement may be necessary before confirmatory evidence is acquired.

Confirmation hinges on demonstration of airflow obstruction varying over short periods of time. Spirometry, which is now becoming more widely available, is preferable to measurement of peak expiratory flow because it allows clearer identification of airflow obstruction, and the results are less dependent on effort. It should be the preferred test where available (although some training is required to obtain reliable recordings and to interpret the results). Of note, a normal spirogram (or PEF) obtained when the patient is not symptomatic does not exclude the diagnosis of asthma.

Results from spirometry are also useful where the initial history and examination leave genuine uncertainty about the diagnosis. In such cases, the differential diagnosis and approach to investigation is different in patients with and without airflow obstruction *(see Figure 2 and Table 6)*. In patients with a normal or near-normal spirogram when symptomatic, potential differential diagnoses are mainly non-pulmonary; [71,72] these conditions do not respond to inhaled corticosteroids and bronchodilators. In contrast, in patients with an obstructive spirogram the question is less whether they will need inhaled treatment but rather exactly what form and how intensive this should be.

Other tests of airflow obstruction, airway responsiveness and airway inflammation can also provide support for the diagnosis of asthma, but to what extent the results of the tests alter the probability of a diagnosis of asthma has not been clearly established, nor is it clear when these tests are best performed.

Table 5: Clinical features in adults that influence the probability that episodic respiratory symptoms are due to asthma

Features that increase the probability of asthma
▪ More than one of the following symptoms: wheeze, breathlessness, chest tightness and cough, particularly if: ◊ symptoms worse at night and in the early morning ◊ symptoms in response to exercise, allergen exposure and cold air ◊ symptoms after taking aspirin or beta blockers ▪ History of atopic disorder ▪ Family history of asthma and/or atopic disorder ▪ Widespread wheeze heard on auscultation of the chest ▪ Otherwise unexplained low FEV_1 or PEF (historical or serial readings) ▪ Otherwise unexplained peripheral blood eosinophilia
Features that lower the probability of asthma
▪ Prominent dizziness, light-headedness, peripheral tingling ▪ Chronic productive cough in the absence of wheeze or breathlessness ▪ Repeatedly normal physical examination of chest when symptomatic ▪ Voice disturbance ▪ Symptoms with colds only ▪ Significant smoking history (ie > 20 pack-years) ▪ Cardiac disease ▪ Normal PEF or spirometry when symptomatic* * A normal spirogram/spirometry when not symptomatic does not exclude the diagnosis of asthma. Repeated measurements of lung function are often more informative than a single assessment.

☑ Base initial diagnosis on a careful assessment of symptoms and a measure of airflow obstruction:

- in patients with a high probability of asthma move straight to a trial of treatment. Reserve further testing for those whose response to a trial of treatment is poor.
- in patients with a low probability of asthma, whose symptoms are thought to be due to an alternative diagnosis, investigate and manage accordingly. Reconsider the diagnosis of asthma in those who do not respond.
- the preferred approach in patients with an intermediate probability of having asthma is to carry out further investigations, including an explicit trial of treatments for a specified period, before confirming a diagnosis and establishing maintenance treatment.

D **Spirometry is the preferred initial test to assess the presence and severity of airflow obstruction.**

2.4.1 FURTHER INVESTIGATION OF PATIENTS WITH AN INTERMEDIATE PROBABILITY OF ASTHMA

Patients with airways obstruction

Tests of peak expiratory flow variability, lung volumes, gas transfer, airway hyper-responsiveness and airway inflammation are of limited value in discriminating patients with established airflow obstruction due to asthma from those whose airflow obstruction is due to other conditions.[73-76] Patients may have more than one cause of airflow obstruction, which complicates the interpretation of any test. In particular, asthma and chronic obstructive pulmonary disease (COPD) commonly coexist.

☑ Offer patients with airways obstruction and intermediate probability of asthma a reversibility test and/or a trial of treatment for a specified period:

- if there is significant reversibility, or if a treatment trial is clearly beneficial treat as asthma
- if there is insignificant reversibility and a treatment trial is not beneficial, consider tests for alternative conditions.*

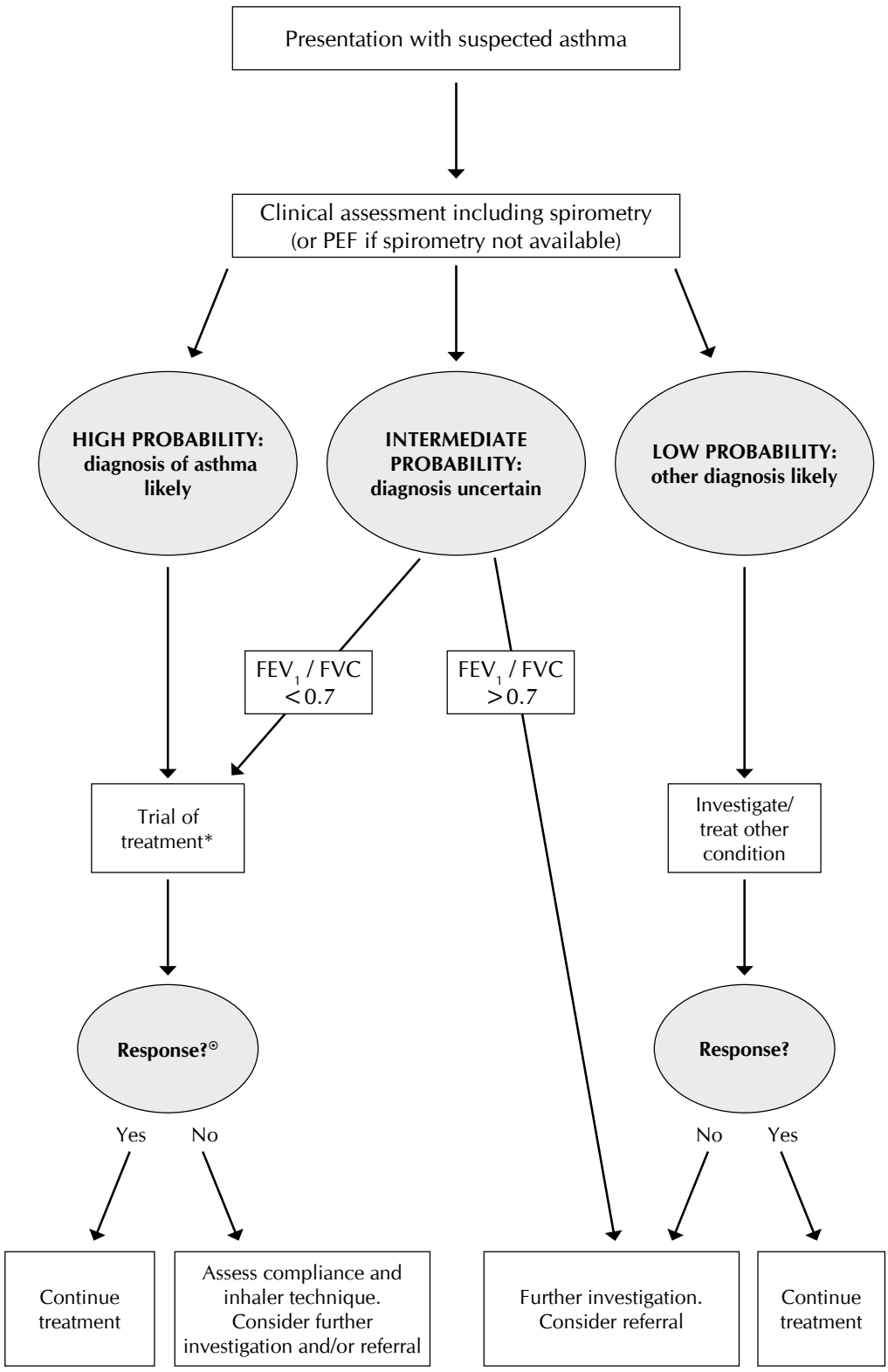
Patients without airways obstruction

In patients with a normal or near-normal spirogram it is more useful to look for evidence of airway hyper-responsiveness and/or airway inflammation [71,77-79] These tests are sensitive so normal results provide the strongest evidence against a diagnosis of asthma.

☑ In patients without evidence of airways obstruction and with an intermediate probability of asthma, arrange further investigations* before commencing treatment.

** see section 2.5 for more detailed information on further tests*

Figure 2: Presentation with suspected asthma in adults



*** See section 2.5.1**
⊙ See Table 6

Table 6: Differential diagnosis of asthma in adults, according to the presence or absence of airflow obstruction ($FEV_1/FVC < 0.7$).

Without airflow obstruction
▪ Chronic cough syndromes ▪ Hyperventilation syndrome ▪ Vocal cord dysfunction ▪ Rhinitis ▪ Gastro-oesophageal reflux ▪ Heart failure ▪ Pulmonary fibrosis
With airflow obstruction
▪ COPD ▪ Bronchiectasis* ▪ Inhaled foreign body* ▪ Obliterative bronchiolitis ▪ Large airway stenosis ▪ Lung cancer* ▪ Sarcoidosis* *may also be associated with non-obstructive spirometry

☑ Consider performing chest X-ray in any patient presenting atypically or with additional symptoms or signs. Additional investigations such as full lung function tests, blood eosinophil count, serum IgE and allergen skin prick tests may be of value in selected patients.

Criteria for referral to a specialist are outlined in box 1.

Box 1: Criteria for specialist referral in adults

- Diagnosis unclear
- Unexpected clinical findings (ie crackles, clubbing, cyanosis, cardiac disease)
- Unexplained restrictive spirometry
- Suspected occupational asthma
- Persistent non-variable breathlessness
- Monophonic wheeze or stridor
- Prominent systemic features (myalgia, fever, weight loss)
- Chronic sputum production
- CXR shadowing
- Marked blood eosinophilia ($> 1 \times 10^9$/l)
- Poor response to asthma treatment
- Severe asthma exacerbation

2.5 FURTHER INVESTIGATIONS THAT MAY BE USEFUL IN PATIENTS WITH AN INTERMEDIATE PROBABILITY OF ASTHMA

Three studies have looked at tests to discriminate patients with asthma from those with conditions that are commonly confused with asthma.[71,77,79] These studies provide a basis for evaluating the diagnostic value of different tests. Table 7 summarises the sensitivity and specificity of different findings on investigation. As not all studies included patients with untreated asthma, these values may underestimate the value of the investigations in clinical practice, where many patients will be investigated before treatment is started. The diagnostic value of testing may also be greater when more than one test is done or if there are previous lung function results available in the patient's notes. The choice of test will depend on a number of factors including severity of symptoms and local availability of tests.

An alternative and promising approach to the classification of airways disease is to use tests which best identify patients who are going to respond to corticosteroid therapy.[78,80] A raised sputum eosinophil count and an increased exhaled nitric oxide concentration (FE_{NO}) are more closely related to corticosteroid response than other tests in a variety of clinical settings.[78,81-83] There is also evidence that markers of eosinophilic airway inflammation are of value in monitoring the response to corticosteroid treatment.[84-86] More experience with these techniques and more information on the long term response to corticosteroid in patients who do not have a raised sputum eosinophil count or FE_{NO} is needed before this approach can be recommended.

Table 7: Estimates of sensitivity and specificity of test results in adults with suspected asthma and normal or near-normal spirometric values.[71,77,79]

Test	Normal range	Validity	
		sensitivity	specificity
Methacholine PC_{20}	> 8 mg/ml	High	Medium
Indirect challenges*	varies	Medium#	High
FE_{NO}	< 25ppb	High#	Medium
Sputum eosinophil count	< 2%	High#	Medium
PEF A%H	< 8** < 20%***	Low	Medium

PC_{20} = the provocative concentration of methacholine required to cause a 20% fall in FEV_1. FE_{NO} = exhaled nitric oxide concentration. PEF A%H = peak expiratory flow amplitude percent highest.

**ie exercise challenge, inhaled mannitol # in untreated patients, **with twice daily readings ***with four or more readings*

2.5.1 TREATMENT TRIALS AND REVERSIBILITY TESTING

Treatment trials with bronchodilators or inhaled corticosteroids in patients with diagnostic uncertainty should use one or more objective methods of assessment. Using spirometric values or PEF as the prime outcome of interest is of limited value in patients with normal or near-normal pre-treatment lung function since there is little room for measurable improvement. One study has shown that the sensitivity of a positive response to inhaled corticosteroid, defined as a >15% improvement in PEF, is 24%.[79] A variety of tools to assess asthma control is available to assess the response to a trial of treatment *(see Table 8)*. 2+

Using FEV_1 or PEF as the primary method to assess reversibility or the response to treatment trials may be more helpful in patients with established airflow obstruction.

In adults, most clinicians would try a 6-8 week treatment trial of 200 mcg inhaled beclometasone (or equivalent) twice daily. In patients with significant airflow obstruction there may be a degree of inhaled corticosteroid resistance [87] and a treatment trial with oral prednisolone 30 mg daily for two weeks is preferred. 2+

A >400 ml improvement in FEV_1 to either β_2 agonists or corticosteroid treatment trials strongly suggests underlying asthma. Smaller improvements in FEV_1 are less discriminatory[71] and a decision on continuation of treatment should be based on objective assessment of symptoms using validated tools *(see Table 8)*. Trials of treatment withdrawal may be helpful where there is doubt. 2+

C **Assess FEV_1 (or PEF) and/or symptoms:**

- **before and after 400 mcg inhaled salbutamol in patients with diagnostic uncertainty and airflow obstruction present at the time of assessment**
- **in other patients, or if there is an incomplete response to inhaled salbutamol, after either inhaled corticosteroids** *(200 mcg twice daily beclometasone equivalent for 6-8 weeks)* **or oral prednisolone** *(30 mg once daily for 14 days)*.

2.5.2 PEAK EXPIRATORY FLOW MONITORING

PEF should be recorded as the best of three forced expiratory blows from total lung capacity with a maximum pause of two seconds before blowing.[88] The patient can be standing or sitting. Further blows should be done if the largest two PEF are not within 40 l/min.[88]

PEF is best used to provide an estimate of variability of airflow from multiple measurements made over at least two weeks. Increased variability may be evident from twice daily readings. More frequent readings will result in a better estimate [89] but the improved precision is likely to be achieved at the expense of reduced patient compliance.[90]

PEF variability is best calculated as the difference between the highest and lowest PEF expressed as a percentage of either the mean or highest PEF.[91-93]

The upper limit of the normal range for the amplitude % highest is around 20% using four or more PEF readings per day [91,93,94] but may be lower using twice daily readings.[95] Epidemiological studies have shown sensitivities of between 19 and 33% for identifying physician-diagnosed asthma. [92,96]

PEF variability can be increased in patients with conditions commonly confused with asthma [71,73] so the specificity of abnormal PEF variability is likely to be less in clinical practice than it is in population studies.

PEF records from frequent readings taken at work and away from work are useful when considering a diagnosis of occupational asthma *(see section 7.8)*. A computer generated analysis of occupational records which provides an index of the work effect is available.[97]

☑ Peak flow records should be interpreted with caution and with regard to the clinical context. They are more useful in the monitoring of patients with established asthma than in making the initial diagnosis.

2.5.3 ASSESSMENT OF AIRWAY RESPONSIVENESS

Tests of airway responsiveness have been useful in research but are not yet widely available in everyday clinical practice. The most widely used method of measuring airway responsiveness relies on measuring response in terms of change in FEV_1 a set time after inhalation of increasing concentrations of histamine or methacholine. The agent can be delivered by breath-activated dosimeter, via a nebuliser using tidal breathing, or via a hand held atomiser.[98] The response is usually quantified as the concentration (or dose) required to cause a 20% fall in FEV_1 (PC_{20} or PD_{20}) calculated by linear interpolation of the log concentration or dose-response curve.

Community studies in adults have consistently shown that airway responsiveness has a unimodal distribution with between 90 and 95% of the normal population having a histamine or methacholine PC_{20} of >8 mg/ml (equivalent to a PD_{20} of >4 micromoles).[92,99,100] This value has a sensitivity of between 60-100% in detecting physician-diagnosed asthma.[92,96,99,100]

In patients with normal or near-normal spirometric values, assessment of airway responsiveness is significantly better than other tests in discriminating patients with asthma from patients with conditions commonly confused with asthma *(see Table 6)*.[71,77] In contrast, tests of airway responsiveness are of little value in patients with established airflow obstruction as the specificity is low.[73,76]

Other potentially helpful constrictor challenges include indirect challenges such as inhaled mannitol and exercise.[101] A positive response to these indirect stimuli (ie a $>15\%$ fall in FEV_1) is a specific indicator of asthma but the tests are less sensitive than tests using methacholine and histamine, particularly in patients tested while on treatment.[101,102]

2.5.4 TESTS OF EOSINOPHILIC AIRWAY INFLAMMATION

Eosinophilic airway inflammation can be assessed non-invasively using the induced sputum differential eosinophil count or the exhaled nitric oxide concentration (FE_{NO}).[103,104] A raised sputum eosinophil count ($>2\%$) or FE_{NO} (>25 ppb at 50 ml/sec) is seen in 70-80% of patients with untreated asthma.[74,103] Neither finding is specific to asthma: 30-40% of patients with chronic cough [82,105,106] and a similar proportion of patients with COPD[81] have abnormal results. There is growing evidence that measures of eosinophilic airway inflammation are more closely linked to a positive response to corticosteroids than other measures even in patients with diagnoses other than asthma. [81,83,105]

Experience with induced sputum and FE_{NO} is limited to a few centres and more research needs to be done before any recommendations can be made.

C **In patients in whom there is diagnostic uncertainty and no evidence of airflow obstruction on initial assessment, test airway responsiveness wherever possible.**

2.6 MONITORING ASTHMA

2.6.1 MONITORING ASTHMA IN CHILDREN

2011

Biomarkers

Studies in children have shown that routine serial measurements of peak expiratory flow,[834-836] airway hyper-responsiveness[837] or exhaled nitric oxide (FE_{NO})[838-841] do not provide additional benefit when added to a symptom based management strategy, as normal lung function does not always indicate well controled asthma. One clinical trial, however, reported that a 90-day average seasonal 5% reduction in peak flow was associated with a 22% increase in risk of exacerbation ($p=0.01$).[842] In a further study of children with asthma who were not taking inhaled corticosteroids, children with FEV_1 80% to 99%, 60% to 79%, and $<60\%$ were 1.3, 1.8, and 4.8, respectively, more likely to have a serious asthma exacerbation in the following four months compared with children with an FEV_1 $\geq 100\%$.[843]

2011 A small prospective observational study in 40 children suggested that serial measurements of FE_{NO} and/or sputum eosinophilia may guide step down of inhaled corticosteroids (ICS).[844] Another small study of 40 children showed that a rising FE_{NO} predicted relapse after cessation of ICS .[840] The number of children involved in these step-down and cessation studies is small and the results should be interpreted with some caution until replicated in larger datasets.

A better understanding of the natural variability of biomarkers independent of asthma is required and studies are needed to establish whether subgroups of patients can be identified in which biomarker guided management is effective. Table 8 summarises the methodology, measurement characteristics and interpretation of some of the validated tools used to assess symptoms and other aspects of asthma.

Clinical issues

When assessing asthma control a general question, such as "how is your asthma today?", is likely to yield a non-specific answer; "I am ok". Using closed questions, such as "do you use your blue inhaler every day?", is likely to yield more useful information. As in any chronic disease of childhood, it is good practice to monitor growth at least annually in children diagnosed with asthma.

2011 ☑ When assessing asthma control use closed questions.

☑ Growth (height and weight centile) should be monitored at least anually in children with asthma.

☑ Practitioners should be aware that the best predictor of future exacerbations is current control.

2.6.2 MONITORING ASTHMA IN ADULTS

In the majority of patients with asthma symptom-based monitoring is adequate. Patients achieving control of symptoms with treatment have a low risk for exacerbations.[107] Patients with poor lung function and with a history of exacerbations in the previous year may be at greater risk of future exacerbations for a given level of symptoms.

2011

2011 ☑ Closer monitoring of individuals with poor lung function and with a history of exacerbations in the previous year should be considered.

In two small studies in a hospital based population, one of which only included patients with severe and difficult asthma, a management strategy that controlled eosinophilic airway inflammation resulted in less exacerbations.[84-86] A strategy which controlled airways responsiveness resulted in a much higher dosage of inhaled corticosteroids and slightly less exacerbations.[108] More research is needed before these strategies can be recommended for widespread use.

Table 8 summarises the methodology, measurement characteristics and interpretation of some of the validated tools used to assess symptoms and other aspects of asthma. Some measures provide information about future risk and potential corticosteroid responsiveness (ie sputum eosinophil count, airway responsiveness and FE_{NO}) rather than immediate clinical control. Risk reduction, eg minimising future adverse outcomes such as exacerbations is an important goal of asthma management. Some patients have an accelerated decline in lung function in terms of FEV_1; risk factors and treatment strategies for these patients are poorly defined. Further research in this area is an important priority.

2011

2011 ☑ When assessing asthma control in adults use specific questions, such as "how many days a week do you use your blue inhaler?".

2.6.3 MONITORING CHILDREN IN PRIMARY CARE

2011

Asthma is best monitored in primary care by routine clinical review on at least an annual basis *(see section 8.1.2)*.

☑ The factors that should be monitored and recorded include:

- symptom score, eg Children's Asthma Control Test, Asthma Control Questionnaire
- exacerbations, oral corticosteroid use and time off school/nursery due to asthma since last assessment
- inhaler technique *(see section 5)*
- adherence *(see section 9.2)*, which can be assessed by reviewing prescription refill frequency
- possession of and use of self management plan/personalised asthma action plan *(see section 9.1)*
- exposure to tobacco smoke
- growth (height and weight centile).

2.6.4 MONITORING ADULTS IN PRIMARY CARE

Asthma is best monitored in primary care by routine clinical review on at least an annual basis *(see section 8.1.2)*.

☑ The factors that should be monitored and recorded include:

- symptomatic asthma control: best assessed using directive questions such as the RCP '3 questions',[109] or the Asthma Control Questionnaire or Asthma Control Test *(see Table 8)*, since broad non-specific questions may underestimate symptoms
- lung function, assessed by spirometry or by PEF. Reduced lung function compared to previously recorded values may indicate current bronchoconstriction or a long term decline in lung function and should prompt detailed assessment. Patients with irreversible airflow obstruction may have an increased risk of exacerbations.
- exacerbations, oral corticosteroid use and time off work or school since last assessment
- inhaler technique *(see section 5)*
- adherence *(see section 9.2)*, which can be assessed by reviewing prescription refill frequency
- bronchodilator reliance, which can be assessed by reviewing prescription refill frequency
- possession of and use of self management plan/personal action plan *(see section 9.1)*.

Table 8: Summary of tools that can be used to assess asthma

Measurement	Methodology	Measurement characteristics	Comments
Spirometry[110, 111]	Widely available. Enables clear demonstration of airflow obstruction. FEV_1 largely independent of effort and highly repeatable. Less applicable in acute severe asthma. Only assesses one aspect of the disease state. Can be achieved in children as young as five years.	Normal ranges widely available and robust. In the short term (20 minute) 95% of repeat measures of FEV_1 <160 ml; FVC <330 ml, independent of baseline value.	Good for short and longer term reversibility testing in adults with pre-existing airflow obstruction. >400 ml increase in FEV_1 post-bronchodilator highly suggestive of asthma in adults. Values usually within normal range in adults and children with asthma.
Peak expiratory flow (PEF)[88,91,92, 112,834-836] 2011	Widely available and simple. Applicable in a wide variety of circumstances including acute severe asthma. PEF variability can be determined from home readings in most patients. PEF effort dependent and not as repeatable as FEV_1.	Normal ranges of PEF are wide, and currently available normative tables are outdated and do not encompass ethnic diversity. Change in PEF more meaningful than absolute value. >60 l/min increase in PEF suggested as best criteria for defining reversibility. Normal range of PEF variability defined as amplitude % highest varies between <8% and <20%. It is likely to depend on number of daily readings and degree of patient coaching.	Useful for short and longer term reversibility testing in adults with pre-existing airflow obstruction. PEF monitoring not proven to improve asthma control in addition to symptom score in adults and children. There may be some benefit in adult patients with more severe disease and in those with poor perception of bronchoconstriction.

Measurement	Methodology	Measurement characteristics	Comments
2011 Royal College of Physicians (RCP) 3 Questions[109]	Yes/no or graded response to the following three questions: In the last week (or month) 1. Have you had difficulty sleeping because of your asthma symptoms (including cough)? 2. Have you had your usual asthma symptoms during the day (cough, wheeze, chest tightness or breathlessness)? 3.Has your asthma interfered with your usual activities (eg housework, work/ school etc)?	No to all questions consistent with controlled asthma.	Not well validated in adults. Not validated in children. Simplicity is attractive for use in day to day clinical practice.
2011 Asthma Control Questionnaire (ACQ)[113-115,845]	Response to 7 questions, 5 relating to symptoms, 1 rescue treatment use and 1 FEV_1. Response usually assessed over the preceding week. Shortened, five question symptom only questionnaire is just as valid.	Well controlled ≤ 0.75, inadequately controlled ≥ 1.5. 95% range for repeat measure $\pm$ 0.36. Minimal important difference 0.5.	Well validated in adults and children older than 5 years A composite scoring system with a strong bias to symptoms. Could be used to assess response to longer term treatment trials. Shortened five-point questionnaire is probably best for those with normal or near normal FEV_1

Measurement	Methodology	Measurement characteristics	Comments
2011 Asthma Control Test (ACT)[116, 117]	Response to 5 questions, 3 related to symptoms, 1 medication use and 1 overall control. 5 point response score	Reasonably well controlled 20-24; under control 25. Within subject intraclass correlation coefficient 0.77. 95% range for repeat measure and minimally clinically important difference not defined.	Validated in adults and children aged over 3 years (Children Asthma Control Test for 4-11 year olds). Could be used to assess response to longer term treatment trials, particularly in those with normal or near normal spirometric values. 95% range for repeat measure and minimally clinically important difference need to be defined.
Mini Asthma Quality of Life Questionnaire (AQLQ)[114,118 ,846] 2011 2011	Response to 15 questions in 4 domains (symptoms, activity limitations, emotional function and environmental stimuli). Response usually assessed over the preceding 2 weeks. Closely related to larger 32-item asthma quality of life questionnaire. The Paediatric Asthma Quality of Life Questionnaire (PAQLQ) has 23 questions each with seven possible responses.	95% range for repeat measure ± 0.36. Minimal important difference 0.5. Scores usually reported as the mean of responses accross the four domains with values lying between 1 and 7; higher scores indicate better quality of life.	Well validated quality of life questionnaire. Could be used to assess response to longer term treatment trials. The AQLQ is validated in adults and the PAQLQ has been validated for the age range 7-17 years.

Measurement	Methodology	Measurement characteristics	Comments
Airway responsiveness [108]	Only available in selected secondary care facilities. Responsive to change (particularly indirect challenges such as inhaled mannitol). Less of a ceiling effect than FEV_1 and PEF. 2011 Not applicable in patients with impaired lung function (ie FEV_1/FVC <0.7 and $FEV_1<70\%$ predicted).	Normal methacholine PC20 >8 mg/ml. 95% range for repeat measure ± 1.5-2 doubling doses.	Has not been widely used to monitor disease and assess treatment responses. 2011 Regular monitoring not proven to improve asthma control in children.
2011 Exhaled nitric oxide (FE_{NO}) [78, 85, 103, 119, 120,840,844]	2011 Increasingly available in secondary care. Monitors still relatively expensive although expect the technology to become cheaper and more widespread. Measurements can be obtained in almost all adults and most children over 5 years. 2011 Results are available immediately. Reasonably close relationship between FE_{NO} and eosinophilic airway inflammation, which is independent of gender, age, atopy and inhaled corticosteroid use. Relationship is lost in smokers. Not closely related to other measures of asthma morbidity.	Normal range <25 ppb at exhaled flow of 50 ml/sec. 95% range for repeat measure 4 ppb. >50 ppb highly predictive of eosinophilic airway inflammation and a positive response to corticosteroid therapy. <25 ppb highly predictive of its absence and a poor response to corticosteroids or successful step down in corticosteroid therapy.	Raised FE_{NO} (>50 ppb in adults and >25 ppb in children) predictive of a positive response to corticosteroids. 2011 The evidence that FE_{NO} can be used to guide corticosteroid treatment is mixed. Protocols for diagnosis and monitoring have not been well defined and more work is needed. Low FE_{NO} (<25 ppb in adults; <20 ppb in the under 12 year old age range) may have a role in identifying patients who can step down corticosteroid treatment safely.

Measurement	Methodology	Measurement characteristics	Comments
Eosinophil differential count in induced sputum [83,84,121,122,844]	Only available in specialist centres although technology is widely available and inexpensive. Information available in 80-90% of patients although immediate results are not available. Sputum eosinophil count not closely related to other measures of asthma morbidity	Normal range < 2%; 95% range for repeat measure ± 2-3 fold.	Close relationship between raised sputum eosinophil count and corticosteroid responsiveness in adults. Use of sputum eosinophil count to guide corticosteroid therapy has been shown to reduce exacerbations in adult patients with severe disease. In children, one study found benefit in using sputum eosinophils to guide reductions of inhaled steroid treatment in conjunction with FENO.

2011

2011 Research is needed to develop exacerbation risk stratification tables on the basis of these data. These might facilitate communication between patients and healthcare professionals resulting in better outcomes, as has been shown in coronary artery disease.

3 Non-pharmacological management

There is a common perception amongst patients and carers that there are numerous environmental, dietary and other triggers of asthma and that avoiding these triggers will improve asthma and reduce the requirement for pharmacotherapy. Failure to address a patient, parent or carer's concern about environmental triggers may compromise concordance with recommended pharmacotherapy. Evidence that non-pharmacological management is effective can be difficult to obtain and more well controlled intervention studies are required.

This section distinguishes:

1. primary prophylaxis - interventions introduced before the onset of disease and designed to reduce its incidence.
2. secondary prophylaxis - interventions introduced after the onset of disease to reduce its impact.

3.1 PRIMARY PROPHYLAXIS

The evidence for primary interventional strategies is based predominantly on observational studies, though some have been tested using experimental methods. Many are multifaceted and it can be difficult to disentangle the effects of one exposure or intervention from another.

3.1.1 AEROALLERGEN AVOIDANCE

Exposure to high levels of house dust mite allergen in early life is associated with an increased likelihood of sensitisation to house dust mite by three to seven years of age.[123] Sensitisation to house dust mite is an important risk factor for the development of asthma[124,125] and a few studies have suggested that high early house dust mite exposure increases the risks of subsequent asthma.[126,127] A UK study showed that low levels of house dust mite and cat allergen exposures in early life increased the risk of IgE sensitisation and asthma at five years, with some attenuation at high levels of exposure, but there were significant interactions with heredity and birth order.[128]

Outcomes from intervention studies attempting to reduce exposure to house dust mites are inconsistent. A multifaceted Canadian intervention study showed a reduced prevalence of doctor-diagnosed asthma but no impact on other allergic diseases, positive skin prick tests or bronchial hyper-responsiveness;[129] others have shown no effect on either allergic sensitisation or symptoms of allergic diseases.[130] In one UK study, early results from environmental manipulation commenced in early pregnancy and focused mainly on house dust mite avoidance, showed reductions in some respiratory symptoms in the first year of life.[131] Subsequent results showed a paradoxical effect with increased allergy but better lung function in the intervention group.[132] 1+

The considerable variation in the methodology used in these studies precludes the merging of data or generation of meta-analyses.

Intensive house dust mite avoidance may reduce exposure to a range of other factors including endotoxin. Epidemiological studies suggest that close contact with a cat or a dog in early life may reduce the subsequent prevalence of allergy and asthma.[133,134] This has raised the question of whether high pet allergen exposure causes high-dose immune tolerance or increases exposure to endotoxin and other microbial products as a component of the "hygiene hypothesis".

In the absence of consistent evidence of benefit from domestic aeroallergen avoidance it is not possible to recommend it as a strategy for preventing childhood asthma.

3.1.2 FOOD ALLERGEN AVOIDANCE

Sensitisation to foods, particularly eggs, frequently precedes the development of aeroallergy and subsequent asthma.[135] Food allergen avoidance in pregnancy and postnatally has not been shown to prevent the later development of asthma.[136] Allergen avoidance during pregnancy may adversely affect maternal, and perhaps fetal, nutrition.[137] High-dose food allergen exposure during pregnancy may reduce subsequent sensitisation rates by inducing tolerance.[138] 1+

B **In the absence of any evidence of benefit and given the potential for adverse effects, maternal food allergen avoidance during pregnancy and lactation is not recommended as a strategy for preventing childhood asthma.**

3.1.3 BREAST FEEDING

A systematic review of observational studies on the allergy preventive effects of breast feeding indicates that it is effective for all infants irrespective of allergic heredity. The preventive effect is more pronounced in high-risk infants provided they are breast fed for at least four months.[139] However, not all studies have demonstrated benefit and in a large birth cohort there was no protective effect against atopy and asthma and maybe even an increase in risk.[140] 2+

Observational studies have the potential to be confounded by, for example, higher rates of breast feeding in atopic families, and taking this into account, the weight of evidence is in favour of breast feeding as a preventive strategy.

C **Breast feeding should be encouraged for its many benefits, and as it may also have a potential protective effect in relation to early asthma.**

3.1.4 MODIFIED INFANT MILK FORMULAE

Trials of modified milk formulae have not included sufficiently long follow up to establish whether there is any impact on asthma. A Cochrane review identified inconsistencies in findings and methodological concerns amongst studies, which mean that hydrolysed formulae cannot currently be recommended as part of an asthma prevention strategy.[141] A review of the use of soy formulae found no significant effect on asthma or any other allergic disease.[142] 1+

In the absence of any evidence of benefit from the use of modified infant milk formulae it is not possible to recommend it as a strategy for preventing childhood asthma.

3.1.5 WEANING

There are conflicting data on the association between early introduction of allergenic foods into the infant diet and the subsequent development of allergy and atopic eczema. No evidence was identified in relation to asthma.[143] In one study late introduction of egg was associated with a non-significant increase in pre-school wheezing.[144]

In the absence of evidence on outcomes in relation to asthma no recommendations on modified weaning can be made.

3.1.6 NUTRITIONAL SUPPLEMENTATION - FISH OILS

Fish oils have a high level of omega-3 polyunsaturated fatty acids (n-3PUFAs). Western diets have a low intake of n-3 PUFAs with a corresponding increase in intake of n-6 PUFAs. This change has been associated with increasing rates of allergic disease and asthma.[143] Two randomised controlled studies have investigated early life fish oil dietary supplementation in relation to asthma outcomes in children at high risk of atopic disease (at least one parent or sibling had atopy with or without asthma). In a study, powered only to detect differences in cord blood, maternal dietary fish oil supplementation during pregnancy was associated with reduced cytokine release from allergen stimulated cord blood mononuclear cells. However, effects on clinical outcomes at one year, in relation to atopic eczema, wheeze and cough, were marginal.[145] In a second study, fish oil supplementation commencing in early infancy with or without additional house dust mite avoidance, was associated with a significant reduction in wheeze at 18 months of age. By five years of age fish oil supplementation was not associated with effects on asthma or other atopic diseases.[146] 1+

In the absence of any evidence of benefit from the use of fish oil supplementation in pregnancy it is not possible to recommend it as a strategy for preventing childhood asthma.

3.1.7 OTHER NUTRIENTS

A number of observational studies have suggested an increased risk of subsequent asthma following reduced (maternal) intakes of selenium (based on umbilical cord levels),[147]or vitamin E based on maternal pregnancy intake.[148] No intervention studies in relation to selenium or vitamin E have yet been conducted and overall there is insufficient evidence to make any recommendations on maternal dietary supplementation as an asthma prevention strategy.[143] Observational studies suggest that intervention trials are warranted.

3.1.8 MICROBIAL EXPOSURE

The "hygiene hypothesis" suggested that early exposure to microbial products would switch off allergic responses thereby preventing allergic diseases such as asthma. The hypothesis is supported by some epidemiological studies comparing large populations who have or have not had such exposure.[149,150]

The concept is sometimes described as "the microbial exposure hypothesis". A double blind placebo controlled trial of the probiotic lactobacillus GG given to mothers resulted in a reduced incidence of atopic eczema in their children but had no effect on IgE antibody or allergic skin test responses. The small sample size and short follow up in this study limit its interpretation.[151] Other trials of a range of probiotics and prebiotics are now in progress. There remains insufficient understanding of the ecology of gut flora in infancy in relation to outcomes. Bifido-bacteria may be more important than lactobacilli in reducing susceptibility to allergic disease.[152]

There is insufficient evidence to indicate that the use of dietary probiotics in pregnancy reduces the incidence of childhood asthma.

This is a key area for further work with longer follow up to establish outcomes in relation to asthma.

3.1.9 AVOIDANCE OF TOBACCO SMOKE AND OTHER AIR POLLUTANTS

No evidence has been found to support a link between exposure to environmental tobacco smoke (ETS) or other air pollutants and the induction of allergy.

There is an increased risk of infant wheezing associated with maternal smoking during pregnancy which adversely affects infant lung function.[153-156] Evidence suggests that early life ETS exposure is associated with later persistent asthma[157,158] with a strong interaction with genetic polymorphisms which affect antioxidant activity.[159] 2+

B **Parents and parents-to-be should be advised of the many adverse effects which smoking has on their children including increased wheezing in infancy and increased risk of persistent asthma.**

The limited data on antenatal or early life exposure to other pollutants suggest similar effects to those for ETS, namely increased infant wheezing, enhanced by additional ETS exposure and antioxidant gene variations.[160-162] There is one small study suggesting that vitamin C supplementation will modify the combined effects of genetic polymorphisms and pollution on lung function in children with asthma.[163] Further research is required before recommendations for practice can be made. 3 4

3.1.10 IMMUNOTHERAPY

Three observational studies with contemporaneous untreated controls in over 8,000 patients have shown that allergen immunotherapy in individuals with a single allergy reduces the numbers subsequently developing new allergic sensitisation over a three to four year follow up.[164-166] One trial compared pollen allergen immunotherapy in children with allergic rhinitis with contemporaneous untreated controls and showed a lower rate of onset of asthma during three years of treatment.[167] This effect was sustained for two years after stopping the therapy.[168] More studies are required to establish whether immunotherapy might have a role in primary prophylaxis.

3.1.11 IMMUNISATION

In keeping with the "microbial exposure hypothesis" some studies have suggested an association between tuberculin responsiveness and subsequent reduced prevalence of allergy, implying a protective effect of BCG. At present, it is not possible to disentangle whether poor tuberculin responsiveness represents an underlying defect which increases the risk of allergy and asthma or whether the immunisation itself has a protective effect.[169] 2^+

Investigation of the effects of any other childhood immunisation suggests that at worst there is no influence on subsequent allergic disease and maybe some protective effect against the development of asthma.[170]

C **All childhood immunisations should proceed normally as there is no evidence of an adverse effect on the incidence of asthma.**

3.2 SECONDARY NON-PHARMACOLOGICAL PROPHYLAXIS

3.2.1 HOUSE DUST MITE AVOIDANCE

Increased allergen exposure in sensitised individuals is associated with an increase in asthma symptoms, bronchial hyper-responsiveness and deterioration in lung function.[127,171,172] However, evidence that reducing allergen exposure can reduce morbidity and/or mortality in asthma is tenuous. In uncontrolled studies, children and adults have derived benefit from removal to a low allergen environment such as occurs at high altitude, although the benefits seen are not necessarily attributable to allergen avoidance alone.[173]

Cochrane reviews on house dust mite control measures in a normal domestic environment have concluded that chemical and physical methods aimed at reducing exposure to house dust mite allergens cannot be recommended.[174] Subsequent studies involving large numbers of patients tend to support this conclusion.[175,176] Heterogeneity between studies with regard to the intervention and monitoring of outcomes makes interpretation of the systematic review difficult. 1^{++}

Studies of mattress barrier systems have suggested that benefits in relation to treatment requirements for asthma and lung function can occur.[177,178] Larger and more carefully conducted controlled studies employing combinations of house dust mite reduction strategies are required. At present house dust mite control measures do not appear to be a cost-effective method of achieving benefit, although it is recognised that many families are very committed to attempts to reduce exposure to triggers. 2^+

Measures to decrease house dust mites have been shown to reduce numbers of house dust mites, but have not been shown to have an effect on asthma severity.

☑ Families with evidence of house dust mite allergy and who wish to try mite avoidance might consider the following:

- complete barrier bed-covering systems
- removal of carpets
- removal of soft toys from bed
- high temperature washing of bed linen
- acaricides to soft furnishings
- good ventilation with or without dehumidification.

3.2.2 OTHER ALLERGENS

Animal allergens, particularly from cat and dog, are potent provokers of asthma symptoms. The reported effects of removal of pets from homes are paradoxical, with either no benefit for asthma[179,180] or a potential for continued high exposure to induce a degree of tolerance.[181] In homes where there is no cat but still detectable cat allergen, there may be a benefit from introducing additional avoidance measures such as air filters and high efficiency vacuum cleaners for cat allergic patients.[182,183]

Although fungal exposure has been strongly associated with hospitalisation and increased mortality in asthma, no controlled trials have addressed the efficacy of reduction of fungal exposure in relation to control of asthma. Cockroach allergy is not a common problem in the UK and studies of attempts to avoid this allergen elsewhere have produced conflicting results.[184]

Studies of individual aeroallergen avoidance strategies show that single interventions have limited or no benefit. A multi faceted approach is more likely to be effective if it addresses all the indoor asthma triggers. Such approaches may even be cost effective.[185] A strategy with a potential impact on mites, mould allergens and indoor pollutants is the use of a mechanical ventilation system to reduce humidity and increase indoor air exchange. The only trial that has assessed this in a controlled fashion failed to demonstrate any significant effects, but the numbers involved were small.[120] A systematic review of this topic concluded that more research is required.[186]

3.3 OTHER ENVIRONMENTAL FACTORS

3.3.1 SMOKING

Direct or passive exposure to cigarette smoke adversely affects quality of life, lung function, need for rescue medications for acute episodes of asthma and long term control with inhaled steroids.[187-190]

There are very few trials which have assessed smoking cessation in relation to asthma control. Two studies have demonstrated decreases in childhood asthma severity when parents were able to stop smoking.[191,192] One study in adults with asthma suggested that smoking cessation improved asthma-specific quality of life, symptoms and drug requirements.[193] Intervention to reduce smoking has had disappointing outcomes.[194,195] It is likely that more intensive intervention will be required to achieve meaningful outcomes.[196] 2+

Uptake of smoking in teenagers increases the risks of persisting asthma. One study showed a doubling of risk for the development of asthma over six years in 14 year old children who started to smoke[197] *(see section 4.2.4 for effect of smoking on treatment).* 3

C **Parents with asthma should be advised about the dangers of smoking to themselves and their children with asthma and offered appropriate support to stop smoking.**

3.3.2 AIR POLLUTION

Challenge studies demonstrate that various pollutants can enhance the response of patients with asthma to allergen inhalation.[198,199] Time-series studies suggest that air pollution may provoke acute asthma attacks or aggravate existing chronic asthma although the effects are very much less than those with infection or allergen exposure.[200,201] While it might seem likely that moving from a highly polluted environment might help, in the UK, asthma is more prevalent in 12-14 year olds in non-metropolitan rather than metropolitan areas.[202] Much less attention has been focused on indoor pollutants in relation to asthma and more work is required.[203,204]

3.3.3 IMMUNOTHERAPY

Subcutaneous immunotherapy

Trials of allergen specific immunotherapy by subcutaneous injection of increasing doses of allergen extracts have consistently demonstrated beneficial effects compared with placebo in the management of allergic asthma. Allergens included house dust mite, grass pollen, tree pollen, cat and dog allergen and moulds. Cochrane reviews have concluded that immunotherapy reduces asthma symptoms, the use of asthma medications and improves bronchial hyper-reactivity. The most recent review included 36 trials with house dust mite, 20 with pollen, 10 with animal allergens, two with cladosporium mould, one with latex and six with multiple allergens.[205] 1++

Evidence comparing the roles of immunotherapy and pharmacotherapy in the management of asthma is lacking. One study directly compared allergen immunotherapy with inhaled steroids and found that symptoms and lung function improved more rapidly in the group on inhaled steroids.[206] Further comparative studies are required. 2+

Immunotherapy for allergic rhinitis has been shown to have a carry over effect after therapy has stopped.[207] 3

B **Immunotherapy can be considered in patients with asthma where a clinically significant allergen cannot be avoided. The potential for severe allergic reactions to the therapy must be fully discussed with patients.**

Sublingual immunotherapy

There has been increasing interest in the use of sublingual immunotherapy, which is associated with far fewer adverse reactions than subcutaneous immunotherapy. A systematic review suggested there were some benefits for asthma control but the magnitude of the effect was small.[208] Further randomised controlled trials are required. 1++

B **Sublingual immunotherapy cannot currently be recommended for the treatment of asthma in routine practice.**

3.4 DIETARY MANIPULATION

3.4.1 ELECTROLYTES

Increasing dietary sodium has been implicated in the geographical variations in asthma mortality[209] and high sodium intake is associated with increased bronchial hyper-responsiveness.[210,211] A systematic review of intervention studies reducing salt intake identified only minimal effects and concluded that dietary salt reduction could not be recommended in the management of asthma.[212] Low magnesium intakes have been associated with a higher prevalence of asthma with increasing intake resulting in reduced bronchial hyper-responsiveness and higher lung function.[213] Magnesium plays a beneficial role in the treatment of asthma through bronchial smooth muscle relaxation, leading to the use of intravenous or inhaled preparations of magnesium sulphate for acute exacerbations of asthma.[214] Studies of oral supplementation are limited and more trials are required.[215-217]

3.4.2 FISH OILS/LIPIDS

In vitro studies suggest that supplementing the diet with omega n-3 fatty acids, which are most commonly found in fish oils, might reduce the inflammation associated with asthma.[218,219] Results from observational studies are inconsistent and a Cochrane review of nine randomised controlled trials concluded that there was insufficient evidence to recommend fish oil supplementation for the treatment of asthma.[220]

3.4.3 ANTIOXIDANTS

Observational studies have reported that low vitamin C, vitamin E and selenium intakes are associated with a higher prevalence of asthma.[143] Intervention studies suggest that neither supplementation with vitamin C, vitamin E or selenium is associated with clinical benefits in people with asthma.[221-223] Observational studies in both adults and children have also consistently shown that a high intake of fresh fruit and vegetable is associated with less asthma and better pulmonary function.[224-230] No intervention studies evaluating the intake of fruit or vegetables and their effects on asthma have been reported.

3.4.4 WEIGHT REDUCTION IN OBESE PATIENTS WITH ASTHMA

Several studies have reported an association between increasing body mass index and symptoms of asthma.[231-234] One randomised parallel group study has shown improved asthma control following weight reduction in obese patients with asthma.[235] 3 1+

C **Weight reduction is recommended in obese patients with asthma to promote general health and to improve asthma control.**

3.4.5 PROBIOTICS

Studies have suggested that an imbalance in gut flora is associated with a higher risk of development of allergy.[236] Trials have investigated the use of probiotics in the treatment of established allergic disease with variable results.[237,238] Only one study focused on asthma, finding a decrease in eosinophilia but no effect on clinical parameters.[239] 1+ 2+

In the absence of evidence of benefit, it is not possible to recommend the use of probiotics in the management of asthma.

3.4.6 IMMUNISATIONS

A number of large studies have concluded that high vaccination coverage has no significant impact on any allergic outcome or asthma. There is a suggestion that the higher the vaccine coverage the greater the possibility that there is a degree of protection against the development of allergy in the first years of life.[240-243]

There is some discussion about whether BCG immunisation may confer protection against allergy and asthma. Research has focused on primary prophylaxis, though there are some studies investigating the use of BCG, with or without allergen, as a means to switch off allergic immune responses. There are some observations suggesting that benefit might occur, [244] but results of trials have been disappointing.[245,246] This is an area that requires further investigation.

There has been concern that influenza vaccination might aggravate respiratory symptoms, though any such effect would be outweighed by the benefits of the vaccination.[247] Studies in children have suggested that immunisation with the vaccine does not exacerbate asthma[248] but has a small beneficial effect on quality of life in children with asthma.[249] The immune response to the immunisation may be adversely affected by high-dose inhaled corticosteroid therapy and this requires further investigation.[250] A Cochrane review of pneumococcal vaccine found very limited evidence to support its use specifically in individuals with asthma.[251] 1++

B **Immunisations should be administered independent of any considerations related to asthma. Responses to vaccines may be attenuated by high-dose inhaled steroids.**

3.5 COMPLEMENTARY AND ALTERNATIVE MEDICINE

Successive reviews have concluded that the evidence to support any recommendations on complementary or alternative medicine is lacking.[252] It is recognised that a lack of evidence does not necessarily mean that treatment is ineffective and high quality research, conducted in the same rigorous and objective fashion as that for conventional therapy, is required.

3.5.1 ACUPUNCTURE

A Cochrane review of 21 trials highlighted many methodological problems with the studies reviewed. Only seven of the trials in 174 patients employed randomisation to active (recognised in traditional Chinese medicine to be of benefit in asthma) or sham acupuncture points (with no recognised activity) for the treatment of persistent or chronic asthma. Blinding was a major problem in the assessment of the results and there were considerable inconsistencies in methodology. The review concluded that there was no evidence for a clinically valuable benefit for acupuncture and no significant benefits in relation to lung function.[253] A later systematic review and meta-analysis of 11 randomised controlled trials found no evidence of an effect in reducing asthma severity but a suggestion that where broncho-constriction was induced to establish efficacy of acupuncture there was a beneficial effect. Concern was expressed about potential preferential publication in favour of positive outcome studies.[254] Two other trials of acupuncture in relation to induced asthma were also negative.[255,256] 1+

3.5.2 AIR IONISERS

Ionisers have been widely promoted as being of benefit for patients with asthma. A Cochrane review of five studies using negative ion generators and one with a positive ion generator found no evidence of benefit in reducing symptoms in patients with asthma.[257] One study demonstrated an increase in night-time cough to a level which approached statistical significance.[258] 1++ 1+

Air ionisers are not recommended for the treatment of asthma.

3.5.3 BREATHING EXERCISES INCLUDING YOGA AND THE BUTEYKO BREATHING TECHNIQUE

The principle of yoga and Buteyko breathing technique is to control hyperventilation by lowering respiratory frequency. A Cochrane review of breathing exercises found no change in routine measures of lung function.[259] One study showed a small reduction in airway responsiveness to histamine utilising pranayama, a form of yoga breathing exercise.[260] 1++ 1+

The Buteyko breathing technique specifically focuses on control of hyperventilation and any ensuing hypocapnia. Four clinical trials suggest benefits in terms of reduced symptoms and bronchodilator usage but no effect on lung function.[261-264] 1+

Buteyko breathing technique may be considered to help patients to control the symptoms of asthma.

3.5.4 HERBAL AND TRADITIONAL CHINESE MEDICINE

A Cochrane review identified 17 trials, nine of which reported some improvement in lung function but it was not clear that the results would be generalisable.[265] A more recent double blind placebo controlled trial of a Chinese herb decoction (Ding Chuan Tang) showed improvement in airway hyper-responsiveness in children with stable asthma.[266] It is difficult to disentangle the effects of multiple ingredients; Ding Chuan Tang for example contains nine components. In a second study,100 children with asthma found that a five-herb mixture gave some benefits in relation to lung function and symptoms compared with placebo.[267] 1+

The conclusions of these trials of Chinese herbal therapy are not generalisable due to variations in the herbal mixtures and study designs. There are likely to be pharmacologically active ingredients in the mixtures and further investigations are warranted. There is a need for large appropriately powered placebo controlled studies.

3.5.5 HOMEOPATHY

A Cochrane review identified only three methodologically sound randomised controlled trials, two of which reported some positive effects. A criticism of the studies was that they did not employ individualised homeopathy, which is the essence of this approach to treatment.[268] A more recent trial of individualised homeopathy in childhood asthma, which was placebo controlled and appropriately powered, failed to show any evidence of benefit over conventional treatment in primary care.[269]

1++
1+

3.5.6 HYPNOSIS AND RELAXATION THERAPIES

A systematic review of relaxation therapies, including hypnotherapy, identified five controlled trials, two of which showed some benefits. Overall the methodology of the studies was poor and the review concluded that there was a lack of evidence of efficacy but that muscle relaxation could conceivably benefit lung function in patients with asthma.[270]

1++

3.6 OTHER COMPLEMENTARY OR ALTERNATIVE APPROACHES

3.6.1 MANUAL THERAPY INCLUDING MASSAGE AND SPINAL MANIPULATION

A Cochrane review identified four relevant RCTs.[271] The two trials of chiropractic suggest that there is no place for this modality of treatment in the management of asthma. No conclusions can be drawn on massage therapy.

3.6.2 PHYSICAL EXERCISE TRAINING

A Cochrane review [259] has shown no effect of physical training on PEF, FEV_1, FVC or VEmax. However, oxygen consumption, maximum heart rate, and work capacity all increased significantly. Most studies discussed the potential problems of exercise induced asthma, but none made any observations on this phenomenon. As physical training improves indices of cardiopulmonary efficiency, it should be seen as part of a general approach to improving lifestyle and rehabilitation in asthma, with appropriate precautions advised about exercise induced asthma *(see section 4.7.2)*.

3.6.3 FAMILY THERAPY

A Cochrane review identified two trials, in 55 children, showing that family therapy may be a useful adjunct to medication in children with asthma.[272] Small study size limits the recommendations.

☑ In difficult childhood asthma, there may be a role for family therapy as an adjunct to pharmacotherapy.

Revised 2011

4 Pharmacological management

The aim of asthma management is control of the disease. Complete control of asthma is defined as:

- no daytime symptoms
- no night-time awakening due to asthma
- no need for rescue medication
- no exacerbations
- no limitations on activity including exercise
- normal lung function (in practical terms FEV_1 and/or PEF > 80% predicted or best).
- minimal side effects from medication.

☑ Lung function measurements cannot be reliably used to guide asthma management in children under five years of age.

In clinical practice patients may have different goals and may wish to balance the aims of asthma management against the potential side effects or inconvenience of taking medication necessary to achieve perfect control.

A stepwise approach aims to abolish symptoms as soon as possible and to optimise peak flow by starting treatment at the level most likely to achieve this. Patients should start treatment at the step most appropriate to the initial severity of their asthma. The aim is to achieve early control and to maintain by stepping up treatment as necessary and stepping down when control is good *(see figures 4, 5 and 6 for summaries of stepwise management in adults and children)*.

☑ Before initiating a new drug therapy practitioners should check adherence with existing therapies *(see section 9.2)*, inhaler technique *(see section 5)* and eliminate trigger factors *(see section 3)*.

Until May 2009 all doses of inhaled steroids in this section were referenced against beclometasone (BDP) given via CFC-MDIs (metered dose inhaler). As BDP CFC is now unavailable, the reference inhaled steroid will be the BDP-HFA product, which is available at the same dosage as BDP-CFC. 2011 Note that some BDP-HFA (hydrofluroalkane) products are more potent and all should be prescribed by brand (see *Table 8b*). Adjustments to doses will have to be made for other inhaler devices and other corticosteroid molecules *(see section 4.2)*.

In this and the following section, each recommendation has been graded and the supporting evidence assessed for adults and adolescents > 12 years old, children 5-12 years, and children under 5 years. The evidence is less clear in children under two and the threshold for seeking an expert opinion should be lowest in these children.

1 2 3 **1 Adults and adolescents aged over 12**
2 Children aged 5-12 years
3 Children under 5 years

Recommendation does not apply to this age group.

4.1 STEP 1: MILD INTERMITTENT ASTHMA

>12 years	5-12 years	<5 years

The following medicines act as short-acting bronchodilators:

>12 years	5-12 years	<5 years
1++	1+	4
1+	1++	
1++		
1++		

- inhaled short-acting β_2 agonists[273]
- inhaled ipratropium bromide[274]
- β_2 agonist tablets or syrup[273]
- theophyllines.[273]

Short-acting inhaled β_2 agonists work more quickly and/or with fewer side effects than the alternatives.[273]

A B D **Prescribe an inhaled short-acting β_2 agonist as short term reliever therapy for all patients with symptomatic asthma.**

4.1.1 FREQUENCY OF DOSING OF INHALED SHORT-ACTING β_2 AGONISTS

>12 years	5-12 years	<5 years
1++	1++	1++

Using short-acting β_2 agonists as required is at least as good as regular (four times daily) administration.[275,276]

Good asthma control is associated with little or no need for short-acting β_2 agonist. Using two or more canisters of β_2 agonists per month or >10-12 puffs per day is a marker of poorly controlled asthma that puts patients at risk of fatal or near-fatal asthma.

☑ Patients with a high usage of inhaled short-acting β_2 agonists should have their asthma management reviewed.

4.2 STEP 2: INTRODUCTION OF REGULAR PREVENTER THERAPY

For steps 2, 3, and 4, treatments have been judged on their ability to improve symptoms, improve lung function, and prevent exacerbations, with an acceptable safety profile. Improvement of quality of life, while important, is the subject of too few studies to be used to make recommendations at present.

4.2.1 COMPARISON OF INHALED STEROIDS

Many studies comparing different inhaled steroids are of inadequate design and have been omitted from further assessment. In view of the clear differences between normal volunteers and asthma patients in the absorption of inhaled steroids, data from normal volunteers have not been taken into account. Only studies in which more than one dose of at least one of the inhaled steroids or both safety and efficacy had been studied together in the same trial were evaluated. Non-blinded studies also had to be considered because of the problems of obtaining competitors' delivery devices. A series of Cochrane reviews comparing different inhaled steroids using a different methodology have come to the same conclusion.

BDP and budesonide are approximately equivalent in clinical practice, although there may be variations with different delivery devices. There is limited evidence from two open studies of less than ideal design that budesonide via the turbohaler is more clinically effective.[295] However, at present a 1:1 ratio should be assumed when changing between BDP and budesonide.

Fluticasone provides equal clinical activity to BDP and budesonide at half the dosage. The evidence that it causes fewer side effects at doses with equal clinical effect is limited. Mometasone appears to provide equal clinical activity to BDP and budesonide at half the dosage.[296] The relative safety of mometasone is not fully established.

Table 8b: Equivalent doses of inhaled steroids relative to BDP and current licensed age indications

These dosage equivalents are approximate and will depend on other factors such as inhaler technique.

		UK licence covers		
Steroid	**Equivalent dose**	**> 12 years**	**5 – 12 years**	**< 5 years**
Beclometasone dipropionate CFC	400 micrograms	**No longer available**		
Beclometasone				
Clenil modulite	400 micrograms	✓	✓	✓
Clickhaler		✓	Over age 6	×
Aerobec Autohaler		✓	×	×
Asmabec Clickhaler		✓	Over age 6	×
Dry powder (Becodisks)		✓	✓	✓
Easyhaler		✓	×	×
Pulvinal		✓	Over age 6	×
Filair		✓	✓	✓
2011 Qvar*	200 to 300 micrograms	✓	×	×
Fostair	200 micrograms	Over age 18	×	×
Budesonide				
Turbohaler	400 micrograms	✓	✓	×
Metered dose inhaler		✓	✓	Over age 2
Easyhaler		✓	Over age 6	×
Novolizer		✓	Over age 6	×
Symbicort		✓	Over age 6	×
Symbicort (regular and as required dosing)		Over age 18	×	×
Fluticasone				
Metered dose inhaler (HFA)	200 micrograms	✓	✓	Over age 4
Accuhaler		✓	✓	Over age 4
Seretide HFA		✓	✓	Over age 4
Seretide (Accuhaler)		✓	✓	Over age 4
Mometasone	200 micrograms	✓	×	×
Ciclesonide	200 to 300 micrograms	✓	×	×

2011 * When changing over to Qvar from BDP-CFC, if (a) control is good on BDP-CFC change to half the dose of Qvar; (b) control is not good on BDP-CFC change to Qvar at the same daily dose.

Ciclesonide is a new inhaled steroid. Evidence from clinical trials suggests that it has less systemic activity and fewer local oropharyngeal side effects than conventional inhaled steroids.[297-301] The clinical benefit of this is not clear as the exact efficacy to safety ratio compared to other inhaled steroids has not been fully established.

Non-CFC beclometasone is available in more than one preparation, and the potency relative to CFC beclometasone is not consistent between these *(see section 5.4)*.

4.2.2 INHALED STEROIDS

>12 years	5-12 years	<5 years
1++	1++	1++

Inhaled steroids are the most effective preventer drug for adults and older children for achieving overall treatment goals.[278-282] There is an increasing body of evidence demonstrating that, at recommended doses, they are also safe and effective in children under five years with asthma.[283-286,847-854]

2011

Many non-atopic children with recurrent episodes of viral-induced wheezing in children under five years do not go on to have chronic atopic asthma. The majority do not require treatment with regular inhaled steroids *(see section 2.1)*.

A A A **Inhaled steroids are the recommended preventer drug for adults and children for achieving overall treatment goals.**

>12 years	5-12 years	<5 years
1+	1+	1+

Inhaled steroids should be considered for adults, children aged 5-12 and children under the age of five with any of the following features: using inhaled β_2 agonists three times a week or more; symptomatic three times a week or more; or waking one night a week. In addition, inhaled steroids should be considered in adults and children aged 5-12 who have had an exacerbation of asthma requiring oral corticosteroids in the last two years.[287,288 ,767-769]

Inhaled steroids should be considered for patients with any of the following asthma-related features:

B C ■ **exacerbations of asthma in the last two years**

B B B **using inhaled β_2 agonists three times a week or more**

B B B **symptomatic three times a week or more**

B C ☑ **waking one night a week.**

Starting dose of inhaled steroids

>12 years	5-12 years	<5 years
1+	1+	

In mild to moderate asthma, starting at very high doses of inhaled steroids and stepping down confers no benefit.[289]

☑ Start patients at a dose of inhaled steroids appropriate to the severity of disease.

☑ In adults, a reasonable starting dose will usually be 400 micrograms BDP per day and in children 200 micrograms BDP per day. In children under five years, higher doses may be required if there are problems in obtaining consistent drug delivery.

☑ Titrate the dose of inhaled steroid to the lowest dose at which effective control of asthma is maintained.

Frequency of dosing of inhaled steroids

>12 years	5-12 years	<5 years
1+	1+	1+

Most current inhaled steroids are slightly more effective when taken twice rather than once daily, but may be used once daily in some patients with milder disease and good or complete control of their asthma.[273, 279,290, 767, 770]

There is little evidence of benefit for dosage frequency more than twice daily.[279]

A A A **Give inhaled steroids initially twice daily, except ciclesonide which is given once daily.**

A A A **Once a day inhaled steroids at the same total daily dose can be considered if good control is established.**

4.2.3 SAFETY OF INHALED STEROIDS

The safety of inhaled steroids is of crucial importance and a balance between benefits and risks for each individual needs to be assessed. Account should be taken of other topical steroid therapy when assessing systemic risk. It has been suggested that steroid warning cards should be issued to patients on higher dose inhaled steroids, but the benefits and possible disadvantages, particularly with regard to adherence, of such a policy remain to be established.

Adults

There is little evidence that doses below 800 micrograms BDP per day cause any short term detrimental effects apart from the local side effects of dysphonia and oral candidiasis. However, the possibility of long term effects on bone has been raised. One systematic review reported no effect on bone density at doses up to 1,000 micrograms BDP per day.[291] The significance of small biochemical changes in adrenocortical function is unknown.

☑ Titrate the dose of inhaled steroid to the lowest dose at which effective control of asthma is maintained.

Children

Administration of inhaled steroids at or above 400 micrograms BDP a day or equivalent may be associated with systemic side effects.[292] These may include growth failure and adrenal suppression. Isolated growth failure is not a reliable indicator of adrenal suppression and monitoring growth cannot be used as a screening test of adrenal function.[290,293]

Clinical adrenal insufficiency has been identified in a small number of children who have become acutely unwell at the time of intercurrent illness. Most of these children had been treated with high doses of inhaled corticosteroids. The dose or duration of inhaled steroid treatment required to place a child at risk of clinical adrenal insufficiency is unknown but is likely to occur at ≥800 micrograms BDP per day or equivalent. The low-dose ACTH test is considered to provide a physiological stimulation of adrenal responsiveness but it is not known how useful such a sensitive test is at predicting clinically relevant adrenal insufficiency.[59,294] In addition, it is unknown how frequently tests of adrenal function would need to be repeated if a child remained on high-dose inhaled corticosteroid. At higher doses, add-on agents, for example, long-acting β_2 agonists, should be actively considered.

While the use of inhaled corticosteroids may be associated with adverse effects (including the potential to reduced bone mineral density) with careful inhaled steroid dose adjustment this risk is likely to be outweighed by their ability to reduce the need for multiple bursts of oral corticosteroids.[771]

2011 ☑ Monitor growth (height and weight centile) of children with asthma on an annual basis.

☑ The lowest dose of inhaled steroids compatible with maintaining disease control should be used.

For children treated with ≥800 micrograms BDP per day or equivalent:

☑ Specific written advice about steroid replacement (eg Steroid Alert Card) in the event of a severe intercurrent illness or surgery should be part of the management plan.

☑ The child should be under the care of a specialist paediatrician for the duration of the treatment.

Adrenal insufficiency is a possibility in any child maintained on inhaled steroids presenting with shock or a decreased level of consciousness; serum biochemistry and blood glucose levels should be checked urgently. Intramuscular (IM) hydrocortisone is required.

4.2.4 SMOKING

>12 years	5-12 years	<5 years
1+		

Current and previous smoking reduces the effect of inhaled steroids; which may be overcome with increased doses.[187,302]

Patients should be advised that smoking reduces the effectiveness of therapy.

B **Clinicians should be aware that higher doses of inhaled steroids may be needed in patients who are smokers or ex-smokers.**

4.2.5 OTHER PREVENTER THERAPIES

>12 years	5-12 years	<5 years
1++	1++	1++
1+	1+	
1++	1+	
1++	1++	1++
1++	1++	1++

Inhaled steroids are the first choice preventer drug. Long-acting inhaled β_2 agonists should not be used without inhaled corticosteroids.[303] Alternative, less effective preventer therapies in patients taking short-acting β_2 agonists alone are:

- Leukotriene receptor antagonists have some beneficial clinical effect[279,309,310]
  - In children under five years who are unable to take inhaled corticosteroids, leukotriene receptor antagonists may be used as an alternative preventer.
- Chromones
  - Sodium cromoglicate is of some benefit in adults[273, 304] and is effective in children aged 5-12[305]
  - Nedocromil sodium is also of benefit in adults and children >5[306,307]
  - There is no clear evidence of benefit with sodium cromoglicate in children aged <5[308]
- Theophyllines have some beneficial effect[273,278]
- Antihistamines and ketotifen are ineffective.[311]

☑ In children under five years who are unable to take inhaled corticosteroids, leukotriene receptor antagonists are an effective first line preventor.

4.3 STEP 3: INITIAL ADD-ON THERAPY

A proportion of patients with asthma may not be adequately controlled at step 2. Before initiating a new drug therapy practitioners should recheck adherence, inhaler technique and eliminate trigger factors. The duration of a trial of add-on therapy will depend on the desired outcome. For instance, preventing nocturnal awakening may require a relatively short trial of treatment (days or weeks), whereas preventing exacerbations of asthma or decreasing steroid tablet use may require a longer trial of therapy (weeks or months). If there is no response to treatment the drug should be discontinued.

4.3.1 CRITERIA FOR INTRODUCTION OF ADD-ON THERAPY

>12 years	5-12 years	<5 years
1++	1+	

No exact dose of inhaled steroid can be deemed the correct dose at which to add another therapy. The addition of other treatment options to inhaled steroids has been investigated at doses from 200-1,000 micrograms BDP in adults and up to 400 micrograms BDP in children.[312-315] Many patients will benefit more from add-on therapy than from increasing inhaled steroids above doses as low as 200 micrograms BDP/day. At doses of inhaled steroid above 800 micrograms BDP/day side effects become more frequent. An absolute threshold for introduction of add-on therapy in all patients cannot be defined.

4.3.2 ADD-ON THERAPY

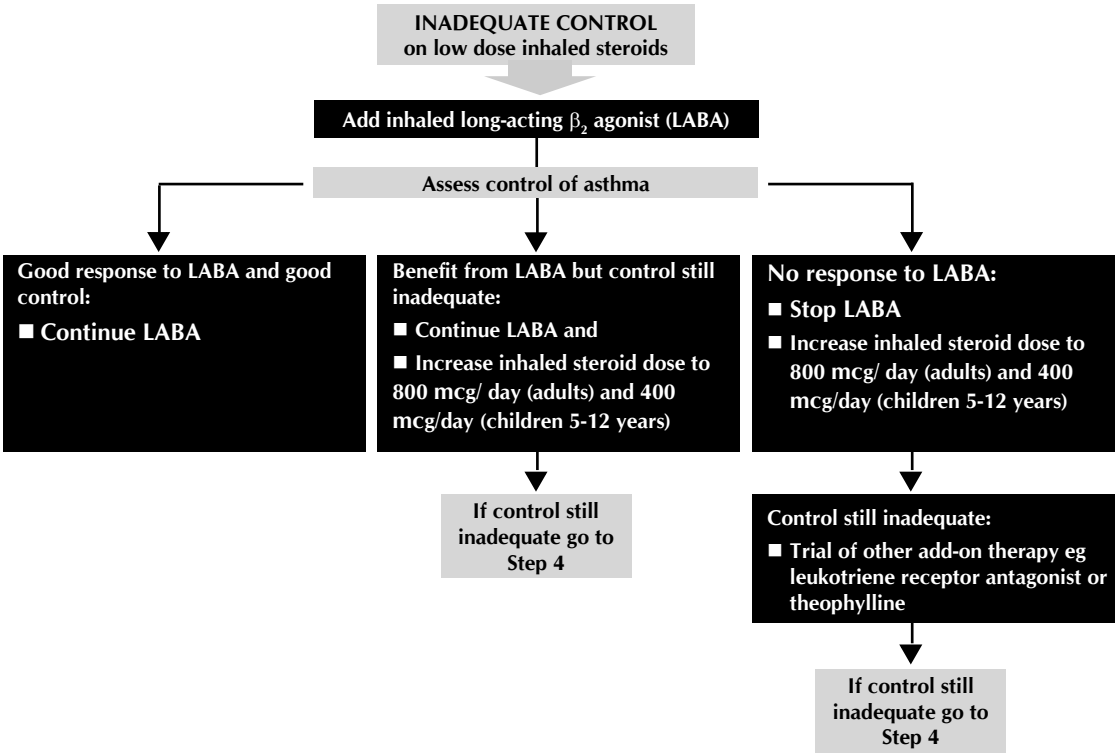
	>12 years	5-12 years	<5 years
Options for add-on therapy are summarised in Figure 3.			
In adult patients taking inhaled steroids at doses of 200-800 micrograms BDP/day and in children taking inhaled steroids at a dose of 400 micrograms/day the following interventions are of value:			
2011 ▪ first choice would be the addition of an inhaled long-acting β_2 agonist (LABA), which improves lung function and symptoms, and decreases exacerbations.[312,316,317, 854-857]	1++	1++	
▪ **Leukotriene receptor antagonists** may provide improvement in lung function, a decrease in exacerbations, and an improvement in symptoms.[310,319,320 ,858]	1++	1++	1+
▪ **Theophyllines** may improve lung function and symptoms, but side effects occur more commonly.[313]	1+	1-	
▪ **Slow-release β_2 agonist tablets** may also improve lung function and symptoms, but side effects occur more commonly.[312]	1++		
A B ■ **The first choice as add-on therapy to inhaled steroids in adults and children** *(5-12 years)* **is an inhaled long-acting β_2 agonist, which should be considered before going above a dose of 400 micrograms BDP or equivalent per day and certainly before going above 800 micrograms BDP.**			
If, as occasionally happens, there is no response to inhaled long-acting β_2 agonist, stop the LABA and increase the dose of inhaled steroid to 800 micrograms BDP/day (adults) or 400 micrograms BDP/day (children) if not already on this dose. If there is a response to LABA, but control remains suboptimal, continue with the LABA and increase the dose of inhaled steroid to 800 micrograms/day (adults) or 400 micrograms/day (children 5-12 years).[318]	4	4	
■ ■ B **The first choice as add-on therapy to inhaled steroids in children under five years old is leukotriene receptor antagonists.**			
D D ■ **If asthma control remains suboptimal after the addition of an inhaled long-acting β_2 agonist then the dose of inhaled steroids should be increased to 800 micrograms/day in adults or 400micrograms day in children** *(5-12 years)***, if not already on these doses.**			
☑ If control remains inadequate after stopping a LABA and increasing the dose of inhaled steroid, consider sequential trials of add-on therapy, ie leukotriene receptor antagonists, theophyllines, slow-release β_2 agonist tablets *(this in adults only)*.			
Addition of short-acting anticholinergics is generally of no value.[314,321] Addition of nedocromil is of marginal benefit.[304,315]	>12 years 1+	5-12 years	<5 years

4.3.3 SAFETY OF LONG-ACTING β_2 AGONISTS

2011 Following a review in 2007 of LABA in the treatment of adults, adolescents, and children with asthma, the Medicines and Healthcare products Regulatory Agency (MHRA) further reviewed the use of LABA, specifically in children younger than age 12 years and concluded that the benefits of these medicines used in conjunction with inhaled corticosteroids in the control of asthma symptoms outweigh any apparent risks.[859]

☑ Long-acting inhaled β_2 agonists should only be started in patients who are already on inhaled corticosteroids, and the inhaled corticosteroid should be continued.

Figure 3: Summary of step 3 in adults and children > 5 years: Add-on therapy



4.3.4 COMBINATION INHALERS

>12 years	5-12 years	<5 years
1++	1++	

2011

In efficacy studies, where there is generally good compliance, there is no difference in efficacy in giving inhaled steroid and a long-acting β_2 agonist in combination or in separate inhalers.[318]

In clinical practice, however it is generally considered that combination inhalers aid compliance and also have the advantage of guaranteeing that the long-acting β_2 agonist is not taken without the inhaled steroids.

☑ Combination inhalers are recommended to:

- guarantee that the long-acting β_2 agonist is not taken without inhaled steroid
- improve inhaler adherence.

Use of a single combination inhaler (SMART)

In selected adult patients at step 3 who are poorly controlled or in selected adult patients at step 2 (above BDP 400 micrograms/day and poorly controlled), the use of budesonide/formoterol in a single inhaler as rescue medication instead of a short-acting β_2 agonist, in addition to its regular use as controller therapy has been shown to be an effective treatment regime.[323-327] When this management option is introduced the total regular dose of daily inhaled corticosteroids should not be decreased. The regular maintenance dose of inhaled steroids may be budesonide 200 micrograms twice daily or budesonide 400 micrograms twice daily. Patients taking rescue budesonide/formoterol once a day or more on a regular basis should have their treatment reviewed. Careful education of patients about the specific issues around this management strategy is required.

4.4 STEP 4: POOR CONTROL ON MODERATE DOSE OF INHALED STEROID + ADD-ON THERAPY: ADDITION OF FOURTH DRUG

In a small proportion of patients asthma is not adequately controlled on a combination of short-acting β_2 agonist as required, inhaled steroid (800 micrograms BDP daily), and an additional drug, usually a long-acting β_2 agonist. There are very few clinical trials in this specific patient group to guide management. The following recommendations are largely based on extrapolation from trials of add-on therapy to inhaled steroids alone *(see section 4.3.2)*.

If control remains inadequate on 800 micrograms BDP daily *(adults)* **and 400 micrograms daily** *(children)* **of an inhaled steroid plus a long-acting β_2 agonist, consider the following interventions:**

- **increasing inhaled steroids to 2000 micrograms BDP/day** *(adults)* **or 800 micrograms BDP/day** *(children 5-12 years)* *****
- **leukotriene receptor antagonists**
- **theophyllines**
- **slow release β_2 agonist tablets, though caution needs to be used in patients already on long-acting β_2 agonists.**

* at high doses of inhaled steroid via MDI, a spacer should be used.

There are no controlled trials indicating which of these is the best option, although the potential for side effects is greater with theophyllines and β_2 agonist tablets.

☑ If a trial of an add-on treatment is ineffective, stop the drug *(or in the case of increased dose of inhaled steroid, reduce to the original dose)*.

☑ Before proceeding to step 5, refer patients with inadequately controlled asthma, especially children, to specialist care.

2011 ☑ Although there are no controlled trials, children (all ages) who are under specialist care may benefit from a trial of higher doses ICS (greater than 800 micrograms/day) before moving to step 5.

4.5 STEP 5: CONTINUOUS OR FREQUENT USE OF ORAL STEROIDS

The aim of treatment is to control asthma using the lowest possible doses of medication.

2011 Some patients with very severe asthma not controlled at step 4 with high dose inhaled corticosteroids, and who have also been tried on or are still taking Long-acting β-agonists, leukotriene antagonists or theophyllines, require regular long term steroid tablets.

☑ For the small number of patients not controlled at step 4, use daily steroid tablets in the lowest dose providing adequate control.

4.5.1 PREVENTION AND TREATMENT OF STEROID TABLET-INDUCED SIDE EFFECTS

Patients on long term steroid tablets (eg longer than three months) or requiring frequent courses of steroid tablets (eg three to four per year) will be at risk of systemic side effects.[59]

- blood pressure should be monitored
- urine or blood sugar and cholesterol should be checked. Diabetes mellitus and hyperlipidaemia may occur
- bone mineral density should be monitored. When a significant reduction occurs, treatment with a long-acting bisphosphonate should be offered (see British Osteoporosis Society guidelines, www.nos.org.uk)[328]
- 2011 bone mineral density should be monitored in children > 5 (see statement from the American Academy of Pediatrics)[943]
- growth (height and weight centile) should be monitored in children
- cataracts may be screened for in children through community optometric services.

4.5.2 STEROID FORMULATIONS

Prednisolone is the most widely used steroid for maintenance therapy in chronic asthma. There is no evidence that other steroids offer an advantage.

4.5.3 FREQUENCY OF DOSING OF STEROID TABLETS

Although popular in paediatric practice, there are no studies to show whether alternate day steroids produce fewer side effects than daily steroids. No evidence was identified to guide timing of dose or dose splitting.

4.5.4 OTHER MEDICATIONS AND POTENTIAL STEROID TABLET-SPARING TREATMENTS

Anti IgE monoclonal antibody

Omalizumab is a humanised monoclonal antibody which binds to circulating IgE, markedly reducing levels of free serum IgE.[774,775] In adults and children over 6 years of age, it is licensed in the UK with the following indication; patients on high-dose inhaled steroids and long-acting β_2 agonists who have impaired lung function are symptomatic with frequent exacerbations, and have allergy as an important cause of their asthma. Omalizumab is given as a subcutaneous injection every two to four weeks depending on dose. The total IgE must be <1300 IU/ml for children over 6 years of age.[860] In adults and children >12 years, the licensed indication is a IgE up to 1500 IU/ml but there is no published data to support its efficacy and safety above 700 IU/ml.

2011

In a study in adults and children >12 years, there was a 19% reduction in exacerbations of asthma requiring oral steroids which was non-significant. When corrected for imbalance in the exacerbation history at baseline, there was a 26% reduction in severe exacerbations (0.91 on placebo vs 0.68 on omalizumab over a 28 week period, p=0.042). This was associated with a 2.8% increase in FEV_1 (p=0.043), a non-significant 0.5 puffs/day decrease in β_2 agonist use and 13% more patients having clinically meaningful improvement in health related quality of life compared with those taking placebo (60.8% vs 47.8%, p=0.008). At IgE levels below 76 IU/ml the beneficial effect is reduced.[776]

>12 years	5-12 years	<5 years
1-	1-	1-

Omalizumab as add-on therapy to inhaled corticosteroids has been studied in children 6-12 years of age with moderate to severe asthma and has been shown to significantly reduce clinically significant exacerbations over a period of 52 weeks. The majority of children were taking long acting β_2 agonists and many a leukotriene antagonist.[860]

2011

>12 years	5-12 years	<5 years
	1++	

Local skin reactions may occur. Anaphylaxis, presenting as bronchospasm, hypotension, syncope, urticaria, and/or angioedema of the throat or tongue has been reported to occur after administration of omalizumab. Anaphylaxis has occurred as early as the first dose, but has also occurred after one year. Due to risk of anaphylaxis, omalizumab should only be administered to patients in a healthcare setting under direct medical supervision.

☑ Omalizumab treatment should only be initiated in specialist centres with experience of evaluation and management of patients with severe and difficult asthma.

Other agents

Immunosuppressants (methotrexate, ciclosporin and oral gold) decrease long term steroid tablet requirements, but all have significant side effects. There is no evidence of persisting beneficial effect after stopping them; and there is marked variability in response.[330]

>12 years	5-12 years	<5 years
1++	3	

☑ Immunosuppressants (methotrexate, ciclosporin and oral gold) may be given as a three month trial, once other drug treatments have proved unsuccessful. Their risks and benefits should be discussed with the patient and their treatment effects carefully monitored. Treatment should be in a centre with experience of using these medicines.

	>12 years	5-12 years	<5 years
Colchicine and intravenous immunoglobulin have not been shown to have any beneficial effect in adults.[330]	1+		
Continuous subcutaneous terbutaline infusion has been reported to be beneficial in severe asthma but efficacy and safety have not been assessed in RCTs.[331,332,772,773]	4	3	3
Anti-TNF alpha therapy has been investigated in severe asthma but these studies are too small and too short term to allow recommendation of anti-TNF therapy outside the context of a controlled clinical trial.[333,334]			

Patients on oral steroids not previously tried on inhaled therapy

For patients who are on long term steroid tablets and have not been tried on adequate doses of inhaled medication an aim is to control the asthma using the lowest possible dose of oral steroid or, if possible, to stop long term steroid tablets completely.

	>12 years	5-12 years	<5 years
Inhaled steroids are the most effective drug for decreasing requirement for long term steroid tablets.[280,281]	1++	4	

There is limited evidence for the ability of long-acting β_2 agonists, theophyllines, or leukotriene receptor antagonists to decrease requirement for steroid tablets, but they may improve symptoms and pulmonary function.[329]

A	D		**In adults, the recommended method of eliminating or reducing the dose of steroid tablets is inhaled steroids, at doses of up to 2,000 micrograms/day, if required.** **In children aged 5-12, consider very carefully before going above an inhaled steroid dose of 800 micrograms/day.**
D	D	D	**There is a role for a trial of treatment with long-acting β_2 agonists, leukotriene receptor antagonists, and theophyllines for about six weeks. They should be stopped if no improvement in steroid dose, symptoms or lung function is detected.**

Figure 4: Summary of stepwise management in adults

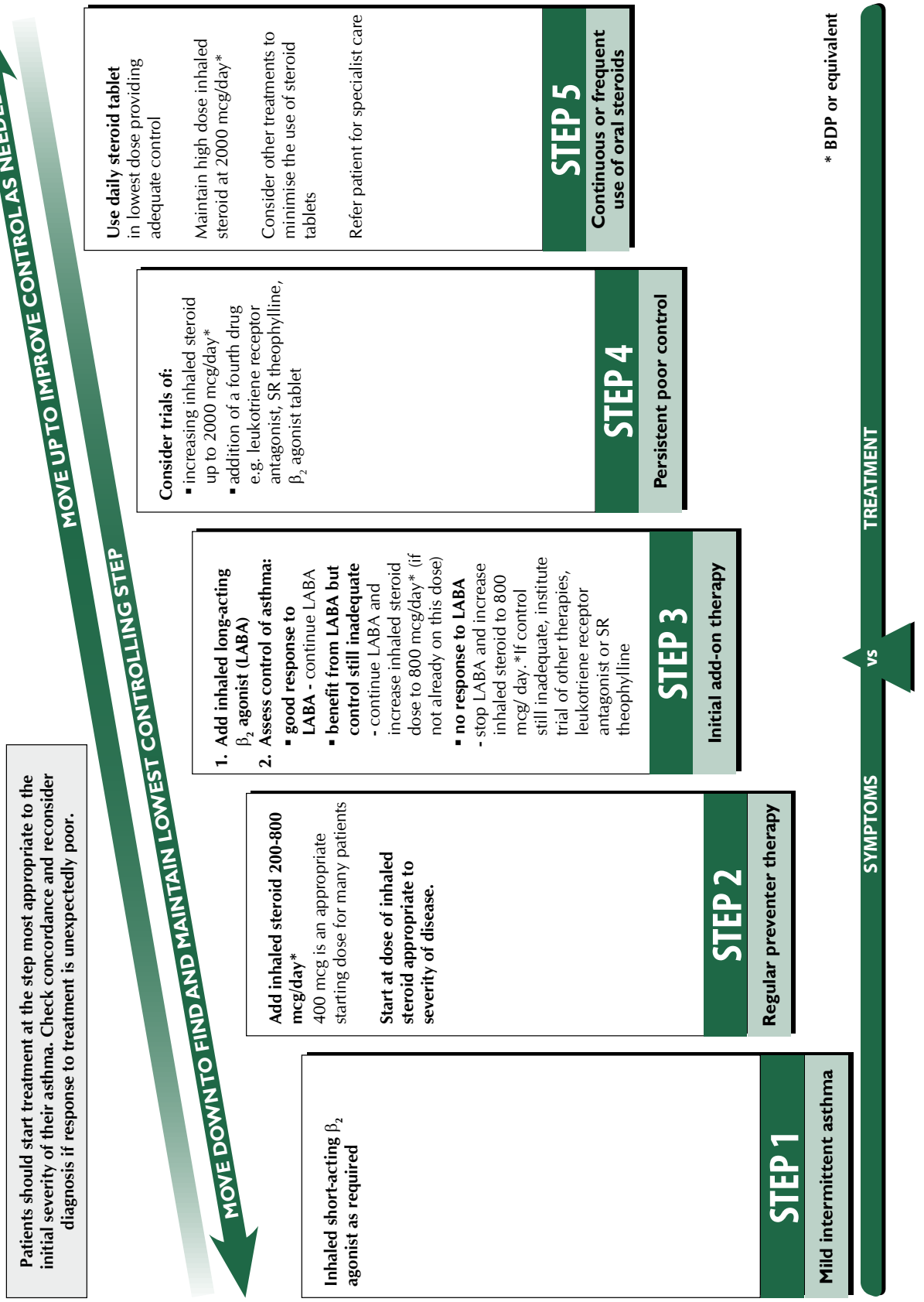


Figure 5: Summary of stepwise management in children aged 5-12 years

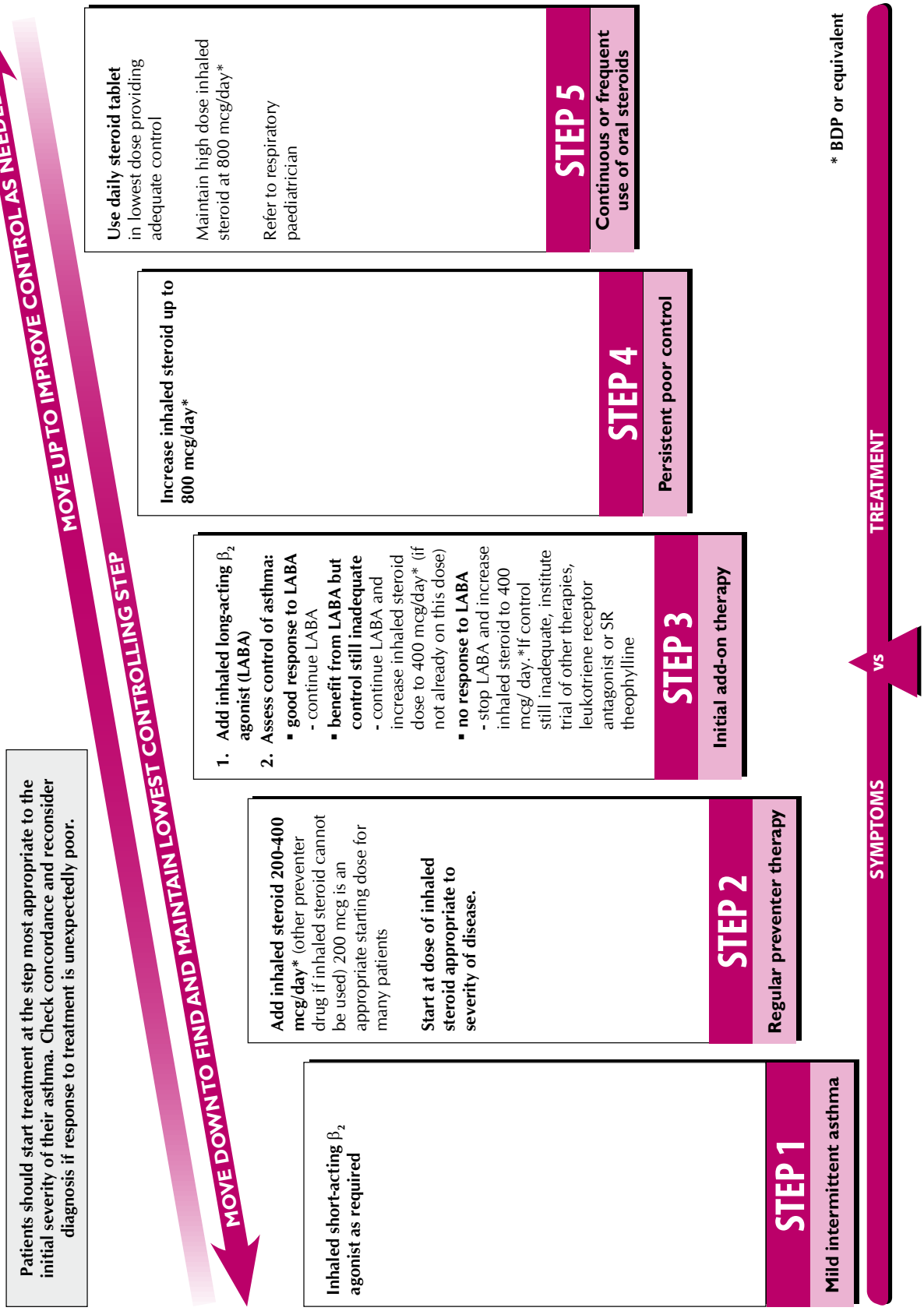
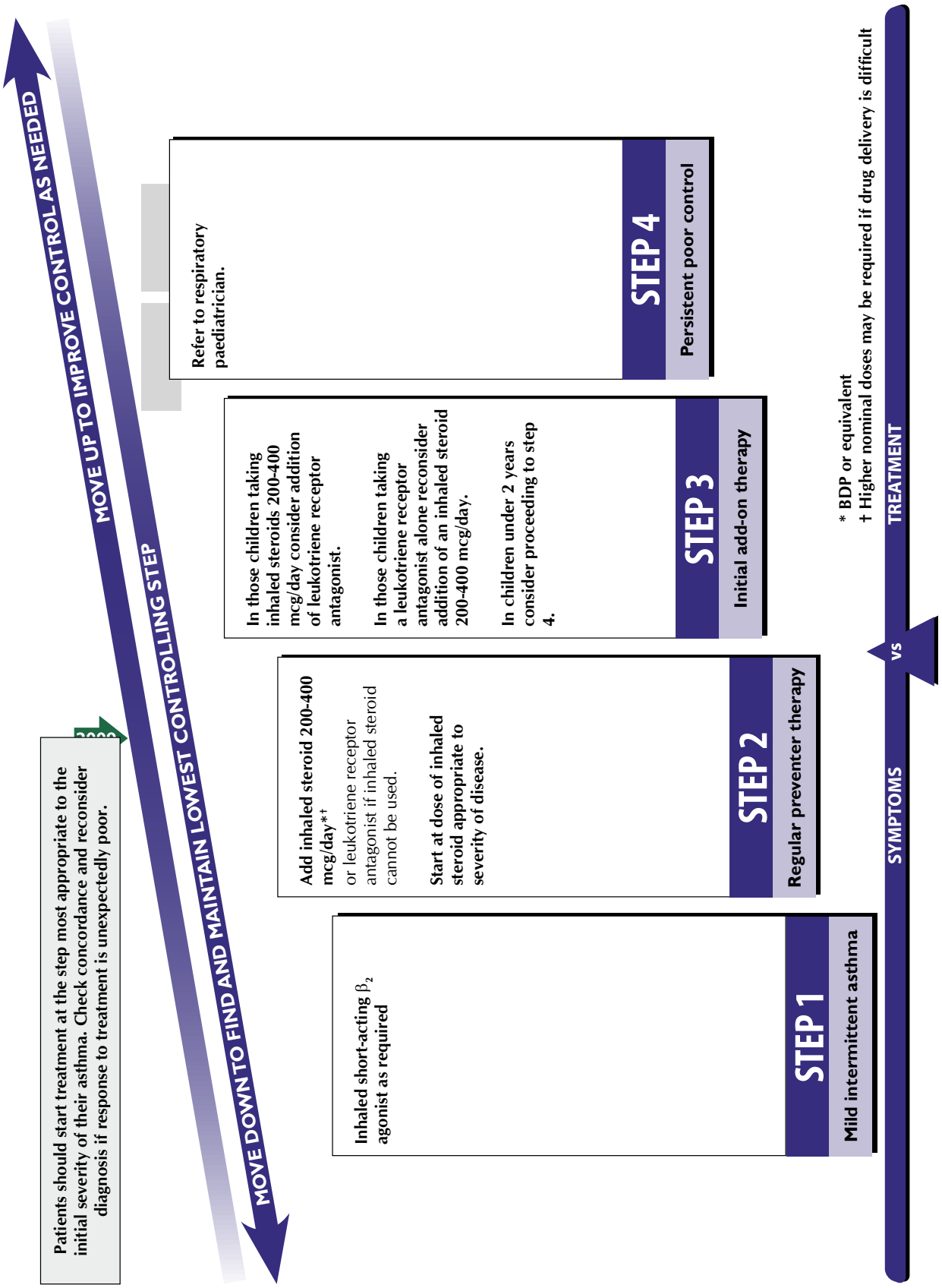


Figure 6: Summary of stepwise management in children less than 5 years



4.6 STEPPING DOWN

Stepping down therapy once asthma is controlled is recommended, but often not implemented leaving some patients over-treated. There are few studies that have investigated the most appropriate way to step down treatment. A study in adults on at least 900 micrograms per day of inhaled steroids has shown that for patients who are stable it is reasonable to attempt to halve the dose of inhaled steroids every three months.[334]

Some children with milder asthma and a clear seasonal pattern to their symptoms may have a more rapid dose reduction during their 'good' season.

☑ Regular review of patients as treatment is stepped down is important. When deciding which drug to step down first and at what rate, the severity of asthma, the side effects of the treatment, time on current dose, the beneficial effect achieved, and the patient's preference should all be taken into account.

☑ Patients should be maintained at the lowest possible dose of inhaled steroid. Reduction in inhaled steroid dose should be slow as patients deteriorate at different rates. Reductions should be considered every three months, decreasing the dose by approximately 25-50% each time.

4.7 SPECIFIC MANAGEMENT ISSUES

4.7.1 EXACERBATIONS OF ASTHMA

Although recommended for both adults and children in previous guidelines and as part of asthma action plans, doubling the dose at the time of an exacerbation is of unproven value.[335] In adult patients on a low dose (200 micrograms BDP) of inhaled steroids, a fivefold increase in dose at the time of exacerbation leads to a decrease in the severity of exacerbations.[335] This study cannot be extrapolated to patients already taking higher doses of inhaled steroids and further evidence in this area is required.

	>12 years	5-12 years	<5 years
There is some limited evidence that leukotriene antagonists may be used intermittently in children with episodic asthma. Treatment is started at the onset of either asthma symptoms or of coryzal symptoms and continued for seven days.[777]		1^{++}	1^{++}

4.7.2 EXERCISE INDUCED ASTHMA

	>12 years	5-12 years	<5 years
The following medicines have been shown to give protection against exercise induced asthma:			
▪ inhaled steroids[280, 281,337]	1^{++}	1^{++}	
2011 ▪ short-acting β_2 agonists[273,861]	1^{++}	1^{++}	
▪ long-acting β_2 agonists[338]	1^{++}	1^{++}	
▪ theophyllines[329,339]	1^{-}	2^{+}	
▪ leukotriene receptor antagonists[340]	1^{++}	2^{+}	
▪ chromones[341]	1^{++}	2^{+}	
▪ β_2 agonist tablets.[342]	1^{++}	1^{+}	
The following medicines do not give protection against exercise induced asthma at normal doses:			
▪ anticholinergics[343]	1^{+}	1^{+}	
▪ ketotifen[344]	1^{+}	1^{+}	
▪ antihistamine.[345]	1^{++}	1^{++}	

>12 years	5-12 years	<5 years
1++	1++	

Long-acting β_2 agonists and leukotriene antagonists provide more prolonged protection than short-acting β_2 agonists, but a degree of tolerance develops with LABA particularly with respect to duration of action. No tolerance has been demonstrated with leukotriene receptor antagonists.[338,340,779]

☑ For most patients, exercise induced asthma is an expression of poorly controlled asthma and regular treatment including inhaled steroids should be reviewed.

If exercise is a specific problem in patients taking inhaled steroids who are otherwise well controlled, consider adding one of the following therapies:

A C ▪ **leukotriene receptor antagonists**

A A ▪ **long-acting β_2 agonists**

C C ▪ **chromones**

A A ▪ **oral β_2 agonists**

C C ▪ **theophyllines.**

>12 years	5-12 years	<5 years
1++	1++	

2011 Immediately prior to exercise, inhaled short-acting β_2 agonists are the drug of choice.[273,861]

A A **Immediately prior to exercise, inhaled short-acting β_2 agonists are the drug of choice.**

4.7.3 RHINITIS

>12 years	5-12 years	<5 years
1+	1+	

2011 Patients with asthma often have rhinitis. The most effective therapy is intranasal steroids.[346,862] Treatment of allergic rhinitis with intranasal steroids has not been shown in double blind placebo-controlled trials to improve asthma control.

4.7.4 ALLERGIC BRONCHOPULMONARY ASPERGILLOSIS

In adult patients with allergic bronchopulmonary aspergillosis (ABPA), itraconazole may decrease steroid tablet dose and improve asthma control.[347,348]

C **In adult patients with ABPA, a four month trial of itraconazole should be considered.**

☑ Careful monitoring for side effects, particularly hepatic, is recommended.

4.7.5 ASPIRIN-INTOLERANT ASTHMA

There are theoretical reasons to suggest that leukotriene receptor antagonists might be of particular value in the treatment of aspirin-intolerant asthma. However, there is little evidence to justify managing patients with aspirin-intolerant asthma in a different manner to other patients with asthma, apart from the rigorous avoidance of non-steroidal anti-inflammatory medications.[349]

4.7.6 GASTRO-OESOPHOGEAL REFLUX

A Cochrane review of twelve double blind controlled trials found that treatment of gastro-oesophageal reflux (GORD) had no benefit on asthma symptoms or lung function when both conditions were present. Reduction in dry cough was observed although this was probably not due to improved asthma control.[350,351]

2011 A systematic review identified a single RCT showing that proton pump inhibitors did not improve asthma symptoms in children with GORD.[863]

4.7.7 β-BLOCKERS

β-blockers, including eye drops, are contraindicated in patients with asthma.

5 Inhaler devices

Although studies of inhaler devices are more suitable for an evidence based approach than many other aspects of asthma management, a number of methodological issues complicate evidence review in this area. In young (0-5 years) children, little or no evidence is available on which to base recommendations.

5.1 TECHNIQUE AND TRAINING

Studies of technique and the effects of training have used arbitrary non-standardised scores making comparison difficult. Although technique will have some bearing, it does not necessarily relate to clinical effectiveness.

The proportion of patients making no mistakes with an inhaler in one well conducted study was 23-43% for pMDI, 53-59% for dry powder inhaler (DPI) and 55-57% for pMDI + spacer. When technique was assessed as number of steps correct out of the total number of steps, pMDI + spacer was slightly better than DPI.[352]

>12 years	5-12 years	<5 years
1++		

Teaching technique improved the correct usage score from a mean of 60% to 79%. Figures for no mistakes post-teaching were 63% for pMDI, 65% for DPI, and 75% for breath-actuated MDI (the latter figure based on one study of 2,467 patients).[352]

B ☑ ☑ **Prescribe inhalers only after patients have received training in the use of the device and have demonstrated satisfactory technique.**

5.2 β_2 AGONIST DELIVERY

5.2.1 ACUTE ASTHMA

pMDI + spacer is at least as good as a nebuliser at treating mild and moderate exacerbations of asthma in children and adults.[353-356]

>12 years	5-12 years	<5 years
1++	1++	

A A B **Children and adults with mild and moderate exacerbations of asthma should be treated by pMDI + spacer with doses titrated according to clinical response.**

There are no data to make recommendations in severe (life threatening) asthma.

5.2.2 STABLE ASTHMA

For children aged 0-5, there is no evidence comparing nebuliser and other inhalers and the data are insufficiently extensive or robust to draw conclusions for pMDI vs. DPI.

In children aged 5-12 there is no significant difference between pMDI and DPI. In adults there is no significant difference between pMDI + spacer and DPI. The lower pulse rate with pMDI v Turbohaler is the only difference with regard to side effects. Patients have been shown to prefer Turbohaler to pMDI.[352,357,358]

>12 years	5-12 years	<5 years
1++	1++	

A **In children aged 5-12, pMDI + spacer is as effective as any other hand held inhaler.**

A **In adults, pMDI ± spacer is as effective as any other hand held inhaler, but patients may prefer some types of DPI.**

There are no data to make recommendations in children under five.

☑ Choice of reliever inhaler for stable asthma should be based on patient preference and assessment of correct use. Many patients will not be prepared to carry a spacer.

5.3 INHALED STEROIDS FOR STABLE ASTHMA

There are no comparative data on inhaled steroids for stable asthma in children under five years. A single study included 4-5 year olds, but the data were not extractable.

For the delivery of inhaled steroids in stable asthma in children aged 5-12 years, pMDI is as effective as Clickhaler,[359,360] and Pulvinal is as effective as Diskhaler.[361] No significant clinical difference was found between pMDI and Turbohaler at half the dose for the same drug (budesonide).[352,362] This comparison cannot necessarily be made against other inhaled steroid /device combinations.

>12 years	5-12 years	<5 years

In adults, there is no clinical difference in effectiveness of pMDI ± spacer v DPI. Breath-actuated MDI is as effective as pMDI. More recent DPIs are as effective as older DPIs.[305] Nebulisers have not been shown to be superior to pMDI + spacer for delivery of inhaled steroids in chronic asthma. A specialised specific nebuliser may provide improved lung function and reduced rescue therapy use, but at high prescribed doses. Higher doses (>2 mg) are generally only licensed for use from a nebuliser.[352,362]

>12 years	5-12 years	<5 years
1++	1++	

A **In children aged 5-12 years, pMDI + spacer is as effective as any DPI.**

A **In adults, a pMDI ± spacer is as effective as any DPI.**

No recommendation can be given for nebulised therapy in children aged 5-12 years and there is no evidence relating to children aged <5 years.

5.4 CFC PROPELLANT PMDI VS HFA PROPELLANT PMDI

HFA pMDI salbutamol is as effective as CFC pMDI salbutamol at standard therapeutic doses.[359,363-368]

>12 years	5-12 years	<5 years
1++		

It is important to differentiate Qvar from other HFA beclametasone products. Many studies now show Qvar equivalence at half the dose of CFC BDP pMDI, whereas non-Qvar HFA BDP pMDI studies show equivalence at 1:1 dosing. [360,369-375]

HFA fluticasone is as effective as CFC fluticasone across the standard clinical dose range.[376-380]

>12 years	5-12 years	<5 years
1++		

A **Salbutamol HFA can be substituted for salbutamol CFC at 1:1 dosing.**

A **HFA BDP pMDI (Qvar) may be substituted for CFC BDP pMDI at 1:2 dosing. This ratio does not apply to reformulated HFA BDP pMDIs.**

A **Fluticasone HFA can be substituted for fluticasone CFC at 1:1 dosing.**

5.5 PRESCRIBING DEVICES

There is no evidence to dictate an order in which devices should be tested for those patients who cannot use pMDI. In the absence of evidence, the most important points to consider are patient preference and local cost.

☑
- The choice of device may be determined by the choice of drug.
- If the patient is unable to use a device satisfactorily an alternative should be found.
- The patient should have their ability to use an inhaler device assessed by a competent healthcare professional *(see section 5.1)*.
- The medication needs to be titrated against clinical response to ensure optimum efficacy.
- Reassess inhaler technique as part of structured clinical review *(see section 8.1.2)*.

☑ In children aged 0-5 years, pMDI and spacer are the preferred method of delivery of β_2 agonists or inhaled steroids. A face mask is required until the child can breathe reproducibly using the spacer mouthpiece. Where this is ineffective a nebuliser may be required.

5.6 USE AND CARE OF SPACERS

☑
- The spacer should be compatible with the pMDI being used.
- The drug should be administered by repeated single actuations of the metered dose inhaler into the spacer, each followed by inhalation.
- There should be minimal delay between pMDI actuation and inhalation.
- Tidal breathing is as effective as single breaths.
- Spacers should be cleaned monthly rather than weekly as per manufacturer's recommendations or performance is adversely affected. They should be washed in detergent and allowed to dry in air. The mouthpiece should be wiped clean of detergent before use.
- Drug delivery may vary significantly due to static charge. Metal and other antistatic spacers are not affected in this way.
- Plastic spacers should be replaced at least every 12 months but some may need changing at six months.

Revised 2009

6 Management of acute asthma

6.1 LESSONS FROM STUDIES OF ASTHMA DEATHS AND NEAR-FATAL ASTHMA

Confidential enquires into over 200 asthma deaths in the UK conclude there are factors associated with the disease, the medical management and the patient's behaviour or psychosocial status which contribute to death. Most deaths occurred before admission to hospital.[381-385]

6.1.1 DISEASE FACTORS

Most patients who died of asthma had chronically severe asthma. In a minority the fatal attack occurred suddenly in a patient with mild or moderately severe background disease.[381-386] 2++

6.1.2 MEDICAL MANAGEMENT

Many of the deaths occurred in patients who had received inadequate treatment with inhaled steroid or steroid tablets and/or inadequate objective monitoring of their asthma. Follow up was inadequate in some and others should have been referred earlier for specialist advice. Asthma deaths are associated with fewer general practice contacts and more home visits.[780] There was widespread under-use of written management plans. Heavy or increasing use of β_2 agonist therapy was associated with asthma death.[381-385,387,388] 2++

2009 Deaths continue to be reported following inappropriate prescription of β-blockers and NSAIDs; all asthma patients should be asked about past reactions to these agents *(see section 4.7.7)*.

2009 Patients with acute asthma should not be sedated unless this is to allow anaesthetic or intensive care procedures (*see section 6.3.12*).[781]

6.1.3 ADVERSE PSYCHOSOCIAL AND BEHAVIOURAL FACTORS

Behavioural and adverse psychosocial factors were recorded in the majority of patients who died of asthma.[381-385] The most important are shown in Table 9.

Table 9: Patients at risk of developing near-fatal or fatal asthma

A COMBINATION OF SEVERE ASTHMA recognised by one or more of:
▪ previous near-fatal asthma, eg previous ventilation or respiratory acidosis ▪ previous admission for asthma especially if in the last year ▪ requiring three or more classes of asthma medication ▪ heavy use of β_2 agonist ▪ repeated attendances at ED for asthma care especially if in the last year ▪ "brittle" asthma.
AND ADVERSE BEHAVIOURAL OR PSYCHOSOCIAL FEATURES recognised by one or more of:
▪ non-compliance with treatment or monitoring ▪ failure to attend appointments ▪ fewer GP contacts (2009) ▪ frequent home visits (2009) ▪ self discharge from hospital ▪ psychosis, depression, other psychiatric illness or deliberate self harm ▪ current or recent major tranquilliser use ▪ denial ▪ alcohol or drug abuse ▪ obesity ▪ learning difficulties ▪ employment problems ▪ income problems ▪ social isolation ▪ childhood abuse ▪ severe domestic, marital or legal stress.

Case control studies support most of these observations.[389,390] Compared with control patients admitted to hospital with asthma, those who died were significantly more likely to have learning difficulties; psychosis or prescribed antipsychotic drugs; financial or employment problems; repeatedly failed to attend appointments or discharged themselves from hospital; drug or alcohol abuse; obesity; or a previous near-fatal attack. 2++

Compared with control patients with asthma in the community, patients who died had more severe disease; more likelihood of a hospital admission or visit to the ED for their asthma in the previous year; more likelihood of a previous near-fatal attack; poor medical management; failure to measure pulmonary function; and non-compliance.

B **Healthcare professionals must be aware that patients with severe asthma and one or more adverse psychosocial factors are at risk of death.**

Studies comparing near-fatal asthma with deaths from asthma have concluded that patients with near-fatal asthma have identical adverse factors to those described in table 9, and that these contribute to the near-fatal asthma attack.[391-393] Compared with patients who die, those with near-fatal asthma are significantly younger, are significantly more likely to have had a previous near-fatal asthma attack, are less likely to have concurrent medical conditions, are less likely to experience delay in receiving medical care, and more likely to have ready access to acute medical care. 2+

With near-fatal asthma it is advisable to involve a close relative when discussing future management.

Patients with brittle or difficult asthma should also be identified *(see sections 6.2.3 and 7.1.1 and Table 10)*.

☑ Keep patients who have had near-fatal asthma or brittle asthma under specialist supervision indefinitely.

6.1.4 SEASONAL FACTORS

In the UK there is a peak of asthma deaths in people aged up to 44 years in July and August and in December and January in older people.[391,394] 2++

6.1.5 PREDICTION AND PREVENTION OF A SEVERE ASTHMA ATTACK

Most attacks of asthma severe enough to require hospital admission develop relatively slowly over a period of six hours or more. In one study, over 80% developed over more than 48 hours.[395-400] There is, therefore, time for effective action to reduce the number of attacks requiring hospitalisation. There are many similarities between patients who die from asthma, patients with near-fatal asthma and control patients with asthma who are admitted to hospital. 2++

☑ A respiratory specialist should follow up patients admitted with severe asthma for at least one year after the admission.

6.2 ACUTE ASTHMA IN ADULTS

Annexes 2-4 contain algorithms summarising the recommended treatment for patients presenting with acute or uncontrolled asthma in primary care *(Annex 2)*, ED *(Annex 3)*, and hospital *(Annex 4)*.

6.2.1 RECOGNITION OF ACUTE ASTHMA

Definitions of increasing levels of severity of acute asthma exacerbations are provided in table 10.[322,401-405] Predicted PEF values[406] should be used only if the recent best PEF (within two years) is unknown. 2+ 4

6.2.2 SELF TREATMENT BY PATIENTS DEVELOPING ACUTE OR UNCONTROLLED ASTHMA

Patients with asthma, and all patients with severe asthma, should have an agreed written action plan and their own peak flow meter, with regular checks of inhaler technique and compliance. They should know when and how to increase their medication and when to seek medical assistance. Asthma action plans can decrease hospitalisation for[407] and deaths from[408] asthma *(see section 9.1)*.

6.2.3 INITIAL ASSESSMENT

All possible initial contact personnel, eg practice receptionists, ambulance call takers, NHS Direct (England and Wales), NHS24 (Scotland), should be aware that asthma patients complaining of respiratory symptoms may be at risk and should have immediate access to a doctor or trained asthma nurse. The assessments required to determine whether the patient is suffering from an acute attack of asthma, the severity of the attack and the nature of treatment required are detailed in tables 10 and 11. It may be helpful to use a systematic recording process. Proformas have proved useful in the ED setting.[409]

Table 10: Levels of severity of acute asthma exacerbations

<table>
<tr><td>Near-fatal asthma</td><td colspan="2">Raised $PaCO_2$ and/or requiring mechanical ventilation with raised inflation pressures[391-393]</td></tr>
<tr><td rowspan="9">Life threatening asthma</td><td colspan="2">Any one of the following in a patient with severe asthma:</td></tr>
<tr><td>Clinical signs</td><td>Measurements</td></tr>
<tr><td>Altered conscious level</td><td>PEF $<33\%$ best or predicted</td></tr>
<tr><td>Exhaustion</td><td>SpO_2 $<92\%$</td></tr>
<tr><td>Arrhythmia</td><td>PaO_2 <8 kPa</td></tr>
<tr><td>Hypotension</td><td>“normal” $PaCO_2$ (4.6–6.0 kPa)</td></tr>
<tr><td>Cyanosis</td><td></td></tr>
<tr><td>Silent chest</td><td></td></tr>
<tr><td>Poor respiratory effort</td><td></td></tr>
<tr><td>Acute severe asthma</td><td colspan="2">Any one of:
- PEF 33-50% best or predicted
- respiratory rate ≥ 25/min
- heart rate ≥ 110/min
- inability to complete sentences in one breath</td></tr>
<tr><td>Moderate asthma exacerbation</td><td colspan="2">- Increasing symptoms
- PEF >50-75% best or predicted
- no features of acute severe asthma</td></tr>
<tr><td>Brittle asthma</td><td colspan="2">- Type 1: wide PEF variability ($>40\%$ diurnal variation for $>50\%$ of the time over a period >150 days) despite intense therapy
- Type 2: sudden severe attacks on a background of apparently well controlled asthma</td></tr>
</table>

6.2.4 PREVENTION OF ACUTE DETERIORATION

A register of patients at risk may help primary care health professionals to identify patients who are more likely to die from their asthma. A system should be in place to ensure that these patients are contacted if they fail to attend for follow up.

6.2.5 CRITERIA FOR REFERRAL

D **Refer to hospital any patients with features of acute severe or life threatening asthma.**

Other factors, such as failure to respond to treatment, social circumstances or concomitant disease, may warrant hospital referral.

Table 11: Initial assessment - the role of symptoms, signs and measurements

	Clinical features	Clinical features can identify some patients with severe asthma, eg severe breathlessness (including too breathless to complete sentences in one breath), tachypnea, tachycardia, silent chest, cyanosis, accessory muscle use, altered consciousness or collapse.[322, 401-405,782]	2+
2009		None of these singly or together is specific. Their absence does not exclude a severe attack.	
	PEF or FEV_1	Measurements of airway calibre improve recognition of the degree of severity, the appropriateness or intensity of therapy, and decisions about management in hospital or at home.[410, 411]	
2009		PEF or FEV_1 are useful and valid measures of airway calibre. PEF is more convenient in the acute situation.	2+
		PEF expressed as a percentage of the patient's previous best value is most useful clinically. PEF as a percentage of predicted gives a rough guide in the absence of a known previous best value. Different peak flow meters give different readings. Where possible the same or similar type of peak flow meter should be used.	
	Pulse oximetry	Measure oxygen saturation (SpO_2) with a pulse oximeter to determine the adequacy of oxygen therapy and the need for arterial blood gas (ABG) measurement. The aim of oxygen therapy is to maintain SpO_2 94-98%.[783]	
2009			
	Blood gases (ABG)	Patients with $SpO_2 < 92\%$ (irrespective of whether the patient is on air or oxygen) or other features of life threatening asthma require ABG measurement.[322, 401-403, 405,413] $SpO_2 < 92\%$ is associated with a risk of hypercapnea. Hypercapnea is not detected by pulse oximetry.[784] In contrast the risk of hypercapnea with $SpO_2 > 92\%$ is much less.[783]	2+ 4
2009			
	Chest X-ray	Chest X-ray is not routinely recommended in patients in the absence of: – suspected pneumomediastinum or pneumothorax – suspected consolidation – life threatening asthma – failure to respond to treatment satisfactorily – requirement for ventilation.	4
	Systolic paradox	Systolic paradox (*pulsus paradoxus*) is an inadequate indicator of the severity of an attack and should not be used.[322, 401-405,414]	2+

6.2.6 CRITERIA FOR ADMISSION

B **Admit patients with any feature of a life threatening or near-fatal attack.**[381-385, 391,393]

B **Admit patients with any feature of a severe attack persisting after initial treatment.**[381-385, 391,393]

C **Patients whose peak flow is greater than 75% best or predicted one hour after initial treatment may be discharged from ED unless they meet any of the following criteria, when admission may be appropriate:**

- **still have significant symptoms**
- **concerns about compliance**
- **living alone/socially isolated**
- **psychological problems**
- **physical disability or learning difficulties**
- **previous near-fatal or brittle asthma**
- **exacerbation despite adequate dose steroid tablets pre-presentation**
- **presentation at night**
- **pregnancy.**

Criteria for admission in adults are summarised in annexes 2 and 3.

6.3 TREATMENT OF ACUTE ASTHMA IN ADULTS

6.3.1 OXYGEN

2009 Many patients with acute severe asthma are hypoxaemic.[415-418] Supplementary oxygen should be given urgently to hypoxaemic patients, using a face mask, Venturi mask or nasal cannulae with flow rates adjusted as necessary to maintain SpO_2 of 94-98%.[783] 2+ 4

2009 Hypercapnea indicates the development of near-fatal asthma and the need for emergency specialist/anaesthetic intervention.

2009 **C** **Give supplementary oxygen to all hypoxaemic patients with acute severe asthma to maintain an SpO_2 level of 94-98%. Lack of pulse oximetry should not prevent the use of oxygen.**

2009 Oxygen-driven nebulisers are preferred for nebulising β_2 agonist bronchodilators because of the risk of oxygen desaturation while using air-driven compressors.[322,353,419] 1++

2009 Emergency oxygen should be available in hospitals, ambulances and primary care. A flow rate of 6 l/min is required to drive most nebulisers. Where oxygen cylinders are used, a high flow regulator must be fitted.[783] 4

2009 The absence of supplemental oxygen should not prevent nebulised therapy from being administered when appropriate.[420] 4

2009 **A** **In hospital, ambulance and primary care, nebulised β_2 agonist bronchodilators should preferably be driven by oxygen.**

6.3.2 β_2 AGONIST BRONCHODILATORS

2009 In most cases inhaled β_2 agonists given in high doses act quickly to relieve bronchospasm with few side effects.[421-423] There is no evidence for any difference in efficacy between salbutamol and terbutaline. Nebulised adrenaline (epinephrine), a non-selective β_2 agonist, does not have significant benefit over salbutamol or terbutaline.[785] 1+ 1++

In acute asthma without life threatening features, β_2 agonists can be administered by repeated activations of a pMDI via an appropriate large volume spacer or by wet nebulisation driven by oxygen, if available.[786] Inhaled β_2 agonists are as efficacious and preferable to intravenous β_2 agonists (meta-analysis has excluded subcutaneous trials) in adult acute asthma in the majority of cases.[424] 1++

Metered dose inhalers with spacers can be used for patients with exacerbations of asthma other than life threatening.[786] 1++

A **Use high-dose inhaled β_2 agonists as first line agents in acute asthma and administer as early as possible. Reserve intravenous β_2 agonists for those patients in whom inhaled therapy cannot be used reliably.**

☑ In acute asthma with life threatening features the nebulised route (oxygen-driven) is recommended.

Parenteral β_2 agonists, in addition to inhaled β_2 agonists, may have a role in ventilated patients or those in extremis; however there is limited evidence to support this.

Most cases of acute asthma will respond adequately to bolus nebulisation of β_2 agonists. Continuous nebulisation of β_2 agonists with an appropriate nebuliser may be more effective than bolus nebulisation in relieving acute asthma for patients with a poor response to initial therapy.[425-427] 1+

A **In severe asthma that is poorly responsive to an initial bolus dose of β_2 agonist, consider continuous nebulisation with an appropriate nebuliser.**

Repeat doses of β_2 agonists at 15-30 minute intervals or give continuous nebulisation of salbutamol at 5-10 mg/hour (requires appropriate nebuliser) if there is an inadequate response to initial treatment. Higher bolus doses, eg 10 mg of salbutamol, are unlikely to be more effective.

6.3.3 STEROID THERAPY

Steroids reduce mortality, relapses, subsequent hospital admission and requirement for β_2 agonist therapy. The earlier they are given in the acute attack the better the outcome.[428,429] 1++

A **Give steroids in adequate doses in all cases of acute asthma.**

Steroid tablets are as effective as injected steroids, provided they can be swallowed and retained.[428] Prednisolone 40-50 mg daily or parenteral hydrocortisone 400 mg daily (100 mg six-hourly) are as effective as higher doses.[430] For convenience, steroid tablets may be given as 2 x 25 mg tablets daily rather than 8-10 x 5 mg tablets. Where necessary soluble prednisolone (sodium phosphate) 5 mg tablets are available. In cases where oral treatment may be a problem consider intramuscular methylprednisolone 160 mg as an alternative to a course of oral prednisolone.[787] 1++

2009

☑ Continue prednisolone 40-50 mg daily for at least five days or until recovery.

Following recovery from the acute exacerbation steroids can be stopped abruptly. Doses do not need tapering provided the patient receives inhaled steroids[431,432] (apart from patients on maintenance steroid treatment or rare instances where steroids are required for three or more weeks). 1+

It is not known if inhaled steroids provide further benefit in addition to systemic steroids. Inhaled steroids should however be started, or continued as soon as possible to commence the chronic asthma management plan.[788,789] 1++

2009

6.3.4 IPRATROPIUM BROMIDE

Combining nebulised ipratropium bromide with a nebulised β_2 agonist produces significantly greater bronchodilation than a β_2 agonist alone, leading to a faster recovery and shorter duration of admission. Anticholinergic treatment is not necessary and may not be beneficial in milder exacerbations of asthma or after stabilisation.[434-436] 1++

B **Add nebulised ipratropium bromide** *(0.5 mg 4-6 hourly)* **to β_2 agonist treatment for patients with acute severe or life threatening asthma or those with a poor initial response to β_2 agonist therapy.**

6.3.5 MAGNESIUM SULPHATE

2009 There is some evidence that, in adults, magnesium sulphate has bronchodilator effects.[790] Experience suggests that magnesium is safe when given by the IV or nebulised route. Trials comparing these routes of administration are awaited. 1++

2009 Studies report the safe use of nebulised magnesium sulphate, in a dose of 135 mg-1152 mg, in combination with β_2 agonists, with a trend towards benefit in hospital admission.[791,792] A single dose of IV magnesium sulphate is safe and may improve lung function in patients with acute severe asthma.[437] 1++

The safety and efficacy of repeated IV doses have not been assessed. Repeated doses could cause hypermagnesaemia with muscle weakness and respiratory failure. 1++

B **Consider giving a single dose of IV magnesium sulphate for patients with:**

- **acute severe asthma who have not had a good initial response to inhaled bronchodilator therapy**
- **life threatening or near fatal asthma.**

☑ IV magnesium sulphate (1.2-2 g IV infusion over 20 minutes) should only be used following consultation with senior medical staff.

2009 More studies are needed to determine the optimal route, frequency and dose of magnesium sulphate therapy.

6.3.6 INTRAVENOUS AMINOPHYLLINE

In acute asthma, IV aminophylline is not likely to result in any additional bronchodilation compared to standard care with inhaled bronchodilators and steroids. Side effects such as arrhythmias and vomiting are increased if IV aminophylline is used.[438] 1++

☑ Use IV aminophylline only after consultation with senior medical staff.

Some patients with near-fatal asthma or life threatening asthma with a poor response to initial therapy may gain additional benefit from IV aminophylline (5 mg/kg loading dose over 20 minutes unless on maintenance oral therapy, then infusion of 0.5-0.7 mg/kg/hr). Such patients are probably rare and could not be identified in a meta-analysis of trials.[438] If IV aminophylline is given to patients on oral aminophylline or theophylline, blood levels should be checked on admission. Levels should be checked daily for all patients on aminophylline infusions.

6.3.7 LEUKOTRIENE RECEPTOR ANTAGONISTS

There is insufficient evidence at present to make a recommendation about the use of leukotriene receptor antagonists in the management of acute asthma.

6.3.8 ANTIBIOTICS

When an infection precipitates an exacerbation of asthma it is likely to be viral. The role of bacterial infection has been overestimated.[439] 1++

B **Routine prescription of antibiotics is not indicated for acute asthma.**

6.3.9 HELIOX

2009

The use of heliox, (helium/oxygen mixture in a ratio of 80:20 or 70:30), either as a driving gas for nebulisers, as a breathing gas, or for artificial ventilation in adults with acute asthma is not supported on the basis of present evidence.[440, 441] A systematic review of ten trials, including 544 patients with acute asthma, found no improvement in pulmonary function or other outcomes in adults treated with heliox, although the possibility of benefit in patients with more severe obstruction exists.[793, 794] Heliox requires the use of specifically designed or modified breathing circuits and ventilators. 1+ 1++

B **Heliox is not recommended for use in acute asthma outside a clinical trial setting.**

6.3.10 INTRAVENOUS FLUIDS

There are no controlled trials, observational or cohort studies of differing fluid regimes in acute asthma. Some patients with acute asthma require rehydration and correction of electrolyte imbalance. Hypokalaemia can be caused or exacerbated by β_2 agonist and/or steroid treatment and must be corrected.

6.3.11 NEBULISED FUROSEMIDE

2009

Although theoretically furosemide may produce bronchodilation, a review of three small trials failed to show any significant benefit of treatment with nebulised furosemide compared to β_2 agonists.[795] 1+

6.3.12 REFERRAL TO INTENSIVE CARE

Indications for admission to intensive care or high-dependency units include patients requiring ventilatory support and those with severe acute or life threatening asthma who are failing to respond to therapy, as evidenced by: 2+

- deteriorating PEF
- persisting or worsening hypoxia
- hypercapnea
- arterial blood gas analysis showing fall in pH or rising H^+ concentration
- exhaustion, feeble respiration
- drowsiness, confusion, altered conscious state
- respiratory arrest.[322,401]

Not all patients admitted to the Intensive Care Unit (ICU) need ventilation, but those with worsening hypoxia or hypercapnea, drowsiness or unconsciousness and those who have had a respiratory arrest require intermittent positive pressure ventilation. Intubation in such patients is very difficult and should ideally be performed by an anaesthetist or ICU consultant. [322,401]

C **All patients transferred to intensive care units should be accompanied by a doctor suitably equipped and skilled to intubate if necessary.**

6.3.13 NON-INVASIVE VENTILATION

Non-invasive ventilation (NIV) is well established in the management of ventilatory failure caused by extrapulmonary restrictive conditions and exacerbations of COPD. Hypercapneic respiratory failure developing during an acute asthmatic episode is an indication for urgent ICU admission. It is unlikely that NIV would replace intubation in these very unstable patients but it has been suggested that this treatment can be used safely and effectively.[442] 4

2009 A Cochrane review found only one trial, with 30 patients, on NIV which showed improvement in hospitalisation rates, discharge from emergency departments and lung function. Larger RCTs are needed to determine the role of NIV in treating patients with acute asthma.[796] 1^{++}

2009 ☑ NIV should only be considered in an ICU or equivalent clinical setting.

6.4 FURTHER INVESTIGATION AND MONITORING

☑
- Measure and record PEF 15-30 minutes after starting treatment, and thereafter according to the response. Measure and record PEF before and after nebulised or inhaled β_2 agonist bronchodilator *(at least four times daily)* throughout the hospital stay and until controlled after discharge.
- Record oxygen saturation by oximetry and maintain arterial SpO_2 at 94-98%.
- Repeat measurements of blood gas tensions within one hour of starting treatment if:
  - the initial PaO_2 is <8 kPa unless SpO_2 is $>92\%$; or
  - the initial $PaCO_2$ is normal or raised; or
  - the patient's condition deteriorates.

2009

☑
- Measure them again if the patient's condition has not improved by 4-6 hours.
- Measure and record the heart rate.
- Measure serum potassium and blood glucose concentrations.
- Measure the serum theophylline concentration if aminophylline is continued for more than 24 hours *(aim at a concentration of 10-20mg/l or 55-110 mol/l)*.

6.5 ASTHMA MANAGEMENT PROTOCOLS AND PROFORMAS

The use of structured proformas facilitates improvements in the process of care in emergency departments and hospital wards and improves patient outcomes. The use of this type of documentation can assist data collection aimed at determining quality of care and outcomes.[409,443,445] 2^{++}

6.6 HOSPITAL DISCHARGE AND FOLLOW UP *(see annex 4)*

6.6.1 TIMING OF DISCHARGE

No single physiological parameter defines absolutely the timing of discharge from an admission with acute asthma. Patients should have clinical signs compatible with home management, be on reducing amounts of β_2 agonist (preferably no more than four hourly) and be on medical therapy they can continue safely at home.

Although diurnal variability of PEF is not always present during an exacerbation, evidence suggests that patients discharged with PEF $<75\%$ best or predicted and with diurnal variability $>25\%$ are at greater risk of early relapse and readmission.[446,447] 2^{+}

6.6.2 PATIENT EDUCATION

Following discharge from hospital or emergency departments, a proportion of patients re-attend with more than 15% re-attending within two weeks. Some repeat attenders need emergency care, but many delay seeking help, and are under-treated and/or under-monitored.[448] 2+

Prior to discharge, trained staff should give asthma education. This should include education on inhaler technique and PEF record keeping, with a written PEF and symptom-based action plan being provided allowing the patient to adjust their therapy within recommendations. These measures have been shown to reduce morbidity after the exacerbation and reduce relapse rates.[449] 1++

2009 There is some experience of a discrete population of patients who use emergency departments rather than primary care services for their asthma care.[90] Education has been shown to reduce subsequent hospital admission and improve attendance at scheduled appointments and self management techniques but does not improve re-attendance at emergency departments.[797] 1++

For the above groups there is a role for a trained asthma liaison nurse based in, or associated with, the emergency department.[797]

See also section 9

6.6.3 FOLLOW UP

A careful history should elicit the reasons for the exacerbation and explore possible actions the patient should take to prevent future emergency presentations.

Medication should be altered depending upon the assessment and the patient provided with an asthma action plan aimed at preventing relapse, optimising treatment and preventing delay in seeking assistance in the future.

Follow up should be arranged prior to discharge with the patient's general practitioner or asthma nurse within two working days; and with a hospital specialist asthma nurse or respiratory physician at about one month after admission.

2009 In a small RCT follow-up care by a nurse specialist was as effective and safe as that given by a respiratory doctor.[798] 1+

2009 Assisting patients in making appointments while being treated for acute asthma in emergency departments may improve subsequent attendance at primary care centres.[799] 1+

☑ It is essential that the patient's primary care practice is informed within 24 hours of discharge from the emergency department or hospital following an asthma exacerbation. Ideally this communication should be directly with a named individual responsible for asthma care within the practice, by means of fax or email.

6.7 ACUTE ASTHMA IN CHILDREN AGED OVER 2 YEARS

6.7.1 CLINICAL ASSESSMENT

Table 12 details criteria for assessment of severity of acute asthma attacks in children. *See also annexes 5-7.*

2009

Table 12: Clinical features for assessment of severity[800]

Life threatening asthma	Any one of the following in a child with severe asthma:	
	Clinical signs	Measurements
	Silent chest	SpO_2 < 92%
	Cyanosis	PEF < 33% best or predicted
	Poor respiratory effort	
	Hypotension	
	Exhaustion	
	Confusion	
Acute severe asthma	Can't complete sentences in one breath or too breathless to talk or feed SpO_2 < 92% PEF 33-50% best or predicted Pulse > 140 in children aged 2-5 years > 125 in children aged > 5 years Respiration > 40 breaths/min aged 2-5 years > 30 breaths/min aged > 5 years	
Moderate asthma exacerbation	Able to talk in sentences SpO_2 ≥ 92% PEF ≥ 50% best or predicted Heart rate ≤140/min in children aged 2-5 years ≤125/min in children > 5 years Respiratory rate ≤ 40/min in children aged 2-5 years ≤ 30/min in children > 5 years	

Before children can receive appropriate treatment for acute asthma in any setting, it is essential to assess accurately the severity of their symptoms. The following clinical signs should be recorded:

- Pulserate
  (increasing tachycardia generally denotes worsening asthma; a fall in heart rate in life threatening asthma is a pre-terminal event)
- Respiratory rate and degree of breathlessness
  (ie too breathless to complete sentences in one breath or to feed)
- Use of accessory muscles of respiration
  (best noted by palpation of neck muscles)
- Amount of wheezing
  (which might become biphasic or less apparent with increasing airways obstruction)
- Degree of agitation and conscious level
  (always give calm reassurance).

Clinical signs correlate poorly with the severity of airways obstruction.[450-453] Some children with acute severe asthma do not appear distressed. 2++

☑ Decisions about admission should be made by trained clinicians after repeated assessment of the response to bronchodilator treatment.

6.7.2 PULSE OXIMETRY

2009

Accurate measurements of oxygen saturation are essential in the assessment of all children with acute wheezing. Oxygen saturation monitors should be available for use by all health professionals assessing acute asthma in both primary and secondary care settings.

Low oxygen saturations after initial bronchodilator treatment selects a more severe group of patients.[450,453] 2++

B **Consider intensive inpatient treatment for children with SpO_2 < 92% in air after initial bronchodilator treatment.**

6.7.3 PEF

2009

PEF measurements can be of benefit in assessing children who are familiar with the use of such devices. The best of three PEF measurements, ideally expressed as a percentage of personal best, can be useful in assessing the response to treatment.

A measurement of < 50% predicted PEF or FEV_1 with poor improvement after initial bronchodilator treatment is predictive of a more prolonged asthma attack.

6.7.4 CHEST X-RAY

Chest X-rays rarely provide additional useful information and are not routinely indicated.[454,455]

2009

☑ A chest X-ray should be performed if there is subcutaneous emphysema, persisting unilateral signs suggesting pneumothorax, lobar collapse or consolidation and/or life threatening asthma not responding to treatment.

6.7.5 BLOOD GASES

2009

Blood gas measurements should be considered if there are life threatening features not responding to treatment. Arteriolised ear lobe blood gases can be used to obtain an accurate measure of pH and pCO_2.[783] If ear lobe sampling is not practicable a finger prick sample can be an alternative. Normal or raised pCO_2 levels are indicative of worsening asthma. A more easily obtained free flowing venous blood pCO_2 measurement of < 6kPA (45mm Hg) excludes hypercapnia.[783] 4

6.8 INITIAL TREATMENT OF ACUTE ASTHMA IN CHILDREN AGED OVER 2 YEARS

2009

There is good evidence supporting recommendations for the initial treatment of acute asthma presenting to primary and secondary healthcare resources. There is less evidence to guide the use of second line therapies to treat the small number of severe cases poorly responsive to first line measures. Despite this, the risks of death and other adverse outcomes after admission to hospital are extremely small irrespective of the treatment options chosen.

2009

☑ β_2 agonists should be given as first line treatment. Increase β_2 agonist dose by two puffs every two minutes according to response up to ten puffs.

2009

☑ Children with acute asthma at home and symptoms not controlled by up to 10 puffs of salbutamol via pMDI and spacer, or 2.5-5 mg of nebulised salbutamol, should seek urgent medical attention. Additional doses of bronchodilator should be given as needed whilst awaiting medical attention if symptoms are severe.

2009

☑ Paramedics attending to children with acute asthma should administer nebulised salbutamol driven by oxygen if symptoms are severe whilst transferring the child to the emergency department.

2009

☑ Children with severe or life threatening asthma should be transferred to hospital urgently.

Emergency units attending to children with acute asthma should have a registered sick children's nurse available on duty at all times and staff familiar with the specific needs of children. Using a proforma can increase the accuracy of severity assessment.

2009 The use of an assessment-driven algorithm and an integrated care pathway has been shown to reduce hospital stay without substantial increases in treatment costs.[801]

D **The use of structured care protocols detailing bronchodilator usage, clinical assessment, and specific criteria for safe discharge is recommended.**

6.8.1 OXYGEN

☑ Children with life threatening asthma or SpO_2 < 94% should receive high flow oxygen via a tight fitting face mask or nasal cannula at sufficient flow rates to achieve normal saturations.

6.8.2 INHALED β_2 AGONISTS (SALBUTAMOL/TERBUTALINE)

A **Inhaled β_2 agonists are the first line treatment for acute asthma.**[457-460]

Assessment of response should be based on accurately recorded clinical observations and repeat measurements of oxygenation (SpO_2). Children receiving β_2 agonists via pMDI + spacer are less likely to have tachycardia and hypoxia than when the same drug is given via a nebuliser.[353] 1+

A **pMDI + spacer is the preferred option in mild to moderate asthma.**

Children aged < 3 years are likely to require a face mask connected to the mouthpiece of a spacer for successful drug delivery. Inhalers should be actuated into the spacer in individual puffs and inhaled immediately by tidal breathing (for five breaths).

Frequent doses of β_2 agonists are safe for the treatment of acute asthma,[457-459] although children with mild symptoms benefit from lower doses.[460] 1+

B **Individualise drug dosing according to severity and adjust according to the patient's response.**

2009 Two to four puffs of a salbutamol 100 mcg repeated every 10-20 minutes according to clinical response might be sufficient for mild attacks although up to 10 puffs might be needed for more severe asthma. Single puffs should be given one at a time and inhaled separately with five tidal breaths. If hourly doses of bronchodilators are needed for more than 4-6 hours, the patient should be switched to nebulised bronchodilators.

2009 Children with severe or life threatening asthma (SpO_2 < 92%) should receive frequent doses of nebulised bronchodilators driven by oxygen (2.5-5 mg salbutamol or 5-10 mg terbutaline).

2009 Doses can be repeated every 20-30 minutes. Continuous nebulised β_2 agonists are of no greater benefit than the use of frequent intermittent doses in the same total hourly dosage.[463,464] If there is poor response to the initial dose of β_2 agonists, subsequent doses should be given in combination with nebulised ipratropium bromide.

2009 ☑ Discontinue long-acting β_2 agonists when short-acting β_2 agonists are required more often than four-hourly.

6.8.3 IPRATROPIUM BROMIDE

2009 There is good evidence for the safety and efficacy of frequent doses of ipratropium bromide (every 20-30 minutes) used in addition to β_2 agonists for the first two hours of a severe asthma attack. Benefits are more apparent in the most severe patients.[471] 1+

A **If symptoms are refractory to initial β_2 agonist treatment, add ipratropium bromide** *(250 mcg/dose mixed with the nebulised β_2 agonist solution).*

2009 Frequent doses up to every 20-30 minutes (250 mcg/dose mixed with 5 mg of salbutamol solution in the same nebuliser) should be used for the first few hours of admission. Salbutamol dose should be weaned to one-to two-hourly thereafter according to clinical response. The ipratropium dose should be weaned to four-to-six-hourly or discontinued. Once improving on two- to four-hourly salbutamol, patients should be switched to pMDI and spacer treatment as tolerated.

☑ Repeated doses of ipratropium bromide should be given early to treat children who are poorly responsive to β_2 agonists.

6.8.4 STEROID THERAPY

Steroid tablets

2009 The early use of steroids in emergency departments and assessment units can reduce the need for hospital admission and prevent a relapse in symptoms after initial presentation.[428, 429] Benefits can be apparent within three to four hours.

A **Give prednisolone early in the treatment of acute asthma attacks.**

A soluble preparation dissolved in a spoonful of water is preferable in those unable to swallow tablets. Use a dose of 20 mg for children 2-5 years old and 30-40 mg for children >5 years.

Oral and intravenous steroids are of similar efficacy.[430,465,466] Intravenous hydrocortisone (4 mg/kg repeated four-hourly) should be reserved for severely affected children who are unable to retain oral medication. 1+

Larger doses do not appear to offer a therapeutic advantage for the majority of children.[467] There is no need to taper the dose of steroid tablets at the end of treatment. 2+

☑ Use a dose of 20 mg prednisolone for children aged 2-5 years and a dose of 30-40 mg for children >5 years. Those already receiving maintenance steroid tablets should receive 2 mg/kg prednisolone up to a maximum dose of 60 mg.

- Repeat the dose of prednisolone in children who vomit and consider intravenous steroids in those who are unable to retain orally ingested medication.
- Treatment for up to three days is usually sufficient, but the length of course should be tailored to the number of days necessary to bring about recovery. Weaning is unnecessary unless the course of steroids exceeds 14 days.[431,432]

Inhaled steroids

There is insufficient evidence to support the use of inhaled steroids as alternative or additional treatment to steroid tablets for acute asthma.[433,468-470]

☑ Do not initiate inhaled steroids in preference to steroid tablets to treat children with acute asthma.

Children with chronic asthma not receiving regular preventative treatment will benefit from initiating inhaled steroids as part of their long term management. There is no evidence that increasing the dose of inhaled steroids is effective in treating acute symptoms, but it is good practice for children already receiving inhaled steroids to continue with their usual maintenance doses.

6.8.5 LEUKOTRIENE RECEPTOR ANTAGONISTS

2009 Initiating oral montelukast in primary care settings, early after the onset of acute asthma symptoms, can result in decreased asthma symptoms and the need for subsequent healthcare attendances in those with mild exacerbations.[777, 802] There is no clear evidence to support the use of leukotriene receptor antagonists for moderate to severe acute asthma.[803] 1+

6.9 SECOND LINE TREATMENT OF ACUTE ASTHMA IN CHILDREN AGED OVER 2 YEARS

2009

Children with continuing severe asthma despite frequent nebulised β_2 agonists and ipratropium bromide plus oral steroids, and those with life threatening features, need urgent review by a specialist with a view to transfer to a high dependency unit or paediatric intensive care unit (PICU) to receive second line intravenous therapies. There are three options to consider; salbutamol, aminophylline and magnesium sulphate.

6.9.1 IV SALBUTAMOL

The role of intravenous β_2 agonists in addition to nebulised treatment remains unclear.[424] One study has shown that an IV bolus of salbutamol given in addition to near-maximal doses of nebulised salbutamol results in clinically significant benefits for those with moderate to severe asthma.[424] 1+

B **Consider early addition of a single bolus dose of intravenous salbutamol** *(15 mcg/kg over 10 minutes)* ***in*** **severe cases where the patient has not responded to initial inhaled therapy.**

2009

A continuous intravenous infusion of salbutamol should be considered when there is uncertainty about reliable inhalation or for severe refractory asthma. This should be given in a high dependency unit with continuous ECG monitoring and twice daily electrolyte monitoring. Doses above 1-2 mcg/kg/min (200 mcg/ml solution) should be given in a PICU setting (up to 5 mcg/kg/min). Nebulised bronchodilators should be continued while the patient is receiving intravenous bronchodilators. Once the patient is improving the intravenous infusion should be reduced before reducing the frequency of nebulised bronchodilators.

2009

☑ When inserting an IV cannula take a blood sample to measure serum electrolytes. Serum potassium levels are often low after multiple doses of β_2 agonists and should be replaced.

6.9.2 IV AMINOPHYLLINE

There is no evidence that aminophylline is of benefit for mild to moderate asthma and side effects are common and troublesome.[438, 472] One well conducted study has shown evidence of benefit in severe acute asthma unresponsive to multiple doses of β_2 agonists and steroids, although the loading dose used was double that currently recommended in the UK and a third of patients were withdrawn from active medication because of vomiting.[473] Two studies have compared intravenous β_2 agonists with intravenous theophylline/aminophylline. One demonstrated equivalence.[804] The other resulted in a shorter period of inpatient treatment among the children receiving an aminophylline bolus followed by infusion but in the salbutamol arm of the study an infusion was not given after the bolus dose.[805] 1+ 2+

2009

A **Aminophylline is not recommended in children with mild to moderate acute asthma.**

C **Consider aminophylline in a HDU or PICU setting for children with severe or life threatening bronchospasm unresponsive to maximal doses of bronchodilators plus steroids.**

A 5 mg/kg loading dose should be given over 20 minutes with ECG monitoring (omit in those receiving maintenance oral theophyllines) followed by a continuous infusion at 1 mg/kg/hour. Measure serum theophylline levels in patients already receiving oral treatment and in those receiving prolonged treatment.

6.9.3 IV MAGNESIUM SULPHATE

Intravenous magnesium sulphate is a safe treatment for acute asthma although its place in management is not yet established.[437,475] Doses of up to 40 mg/kg/day (maximum 2 g) by slow infusion have been used. Studies of efficacy for severe childhood asthma unresponsive to more conventional therapies have been inconsistent in providing evidence of benefit. 1+

6.9.4 OTHER THERAPIES

There is no evidence to support the use of heliox, DNase or mucolytics for the treatment of acute asthma in childhood. Nebulised magnesium sulphate is being evaluated as a treatment for acute asthma but is not yet recommended.

There is insufficient evidence to support or refute the role of antibiotics in acute asthma,[305] but the majority of acute asthma attacks are triggered by viral infection.

☑ Do not give antibiotics routinely in the management of children with acute asthma.

6.9.5 DISCHARGE PLANNING

Children can be discharged when stable on 3-4 hourly inhaled bronchodilators that can be continued at home.[476] PEF and/or FEV_1 should be >75% of best or predicted and SpO_2 >94%.

Adult studies show that "optimal care" comprising self monitoring, regular review and a written asthma action plan can improve outcomes.[407] Acute asthma attacks should be considered a failure of preventive therapy and thought should be given about how to help families avoid further severe episodes.

Discharge plans should address the following:

- check inhaler technique
- consider the need for preventer treatment
- 2009 provide a written asthma action plan for subsequent asthma exacerbations with clear instructions about the use of bronchodilators and the need to seek urgent medical attention in the event of worsening symptoms not controlled by up to 10 puffs of salbutamol 4 hourly
- arrange follow up by primary care services within 48 hours
- arrange follow up in a paediatric asthma clinic within one to two months
- 2009 arrange referral to a paediatric respiratory specialist if there have been life threatening features.

6.10 ASSESSMENT OF ACUTE ASTHMA IN CHILDREN AGED LESS THAN 2 YEARS

The assessment of acute asthma in early childhood can be difficult *(see Annex 8)*. Intermittent wheezing attacks are usually due to viral infection and the response to asthma medication is inconsistent. Prematurity and low birth weight are risk factors for recurrent wheezing. The differential diagnosis of symptoms includes aspiration pneumonitis, pneumonia, bronchiolitis, tracheomalacia, and complications of underlying conditions such as congenital anomalies and cystic fibrosis. These guidelines are intended for those who are thought to have asthma causing acute wheeze. They should not be used as a guide for treating acute bronchiolitis (see SIGN 91: Bronchiolitis in children).[806]

6.11 TREATMENT OF ACUTE ASTHMA IN CHILDREN AGED LESS THAN 2 YEARS

6.11.1 β_2 AGONIST BRONCHODILATORS

A trial of bronchodilator therapy should be considered when symptoms are of concern. If inhalers have been successfully administered but there is no response, review the diagnosis and consider the use of other treatment options.

Inhaled β_2 agonists are the initial treatment of choice for acute asthma. Close fitting face masks are essential for optimal drug delivery. The dose received is increased if the child is breathing appropriately and not taking large gasps because of distress and screaming.

There is good evidence that pMDI + spacer is as effective as, if not better than, nebulisers for treating mild to moderate asthma in children aged ≤ 2 years.[355,478,479] | 1^+

A **For mild to moderate acute asthma, a pMDI + spacer is the optimal drug delivery device.**

Whilst β_2 agonists offer marginal benefits to children aged < 2 years with acute wheeze, there is little evidence for an impact on the need for hospital admission or length of hospital stay.[480-482] | 1^+

Oral β_2 agonists have not been shown to affect symptom score or length of hospital stay for acute asthma in infancy when compared to placebo.[477] | 1^+

B **Oral β_2 agonists are not recommended for acute asthma in infants.**

6.11.2 STEROID THERAPY

Steroid tablets in conjunction with β_2 agonists have been shown to reduce hospital admission rates when used in the emergency department.[483] Steroid tablets have also been shown to reduce the length of hospital stay.[477,480,483] | 1^+

B **Consider steroid tablets in infants early in the management of severe episodes of acute asthma in the hospital setting.**

One study has shown similar benefits when comparing oral and nebulised steroids for acute asthma.[480]

☑ Steroid tablet therapy *(10 mg of soluble prednisolone for up to three days)* is the preferred steroid preparation for use in this age group.

6.11.3 IPRATROPIUM BROMIDE

The addition of ipratropium bromide to β_2 agonists for acute severe asthma may lead to some improvement in clinical symptoms and reduce the need for more intensive treatment. It does not reduce the length of hospital stay either in combination with β_2 agonists or in comparison with placebo.[484] | 1^+

B **Consider inhaled ipratropium bromide in combination with an inhaled β_2 agonist for more severe symptoms.**

6.11.4 FURTHER INVESTIGATION AND MONITORING

Many children with recurrent episodes of viral-induced wheezing in infancy do not go on to have chronic atopic asthma. The majority do not require treatment with regular inhaled steroids. Parents should be advised about the relationship between cigarette smoke exposure and wheezy illnesses *(see sections 3.1.9 and 3.3.1)*. Referral to suitable agencies should be offered to those who wish to give up smoking.

Parents of wheezy infants should receive appropriate discharge plans along similar lines to those given for older children *(see section 6.9.5)*.

7 Special situations

New 2011

7.1 ASTHMA IN ADOLESCENTS

7.1.1 DEFINITIONS

Adolescence is the transitional period of growth and development between puberty and adulthood, defined by the World Health Organisation (WHO) as between 10 and 19 years of age.[864]

There is international agreement on best practice for working with adolescents with health problems outlined in consensus publications.[865-867] Key elements of working effectively with adolescents in the transition to adulthood include:[868]

- seeing them on their own, separate from their parents or carers, for part of the consultation, and
- discussing confidentiality and its limitations.

For diagnosing and managing asthma in adolescents, the evidence base is limited. Much recent research has focused on the prevalence of asthma and ecological risk associations rather than on diagnosis and management of asthma in adolescents.

7.1.2 PREVALENCE OF ASTHMA IN ADOLESCENCE

Asthma is common in adolescence with a prevalence of wheeze in Western Europe in the past 12 months (current wheeze) in 13-14 year olds of 14.3%.[869] For more severe asthma (defined as ≥4 attacks of wheeze or ≥1 night per week sleep disturbance from wheeze or wheeze affecting speech in the past 12 months) the prevalence was 6.2%.

There is evidence of under-diagnosis of asthma in adolescents, with estimates of 20-30% of all asthma present in this age group being undiagnosed.[869-872] This has been attributed to under-reporting of symptoms. A number of risk factors have independently been associated with under-diagnosis including: female gender, smoking (both current smoking and passive exposure), low socioeconomic status, family problems, low physical activity and high body mass and race/ethnicity.[872] Children with undiagnosed frequent wheezing do not receive adequate healthcare for their illness[872] and the health consequences of not being diagnosed with asthma are substantial.[873,874]

Although feasible, there is insufficient evidence to support screening for asthma in adolescents.[875,876]

☑ Clinicians seeing adolescents with any cardio-respiratory symptoms should consider asking about symptoms of asthma.

7.1.3 DIAGNOSIS AND ASSESSMENT

No evidence was identified to suggest that the symptoms and signs of asthma in adolescents are different from those of other age groups.

Exercise-related symptoms

Exercise-related wheezing and breathlessness are common asthma symptoms in adolescents. However, these symptoms are poor predictors of exercise-induced asthma. Only a minority of adolescents referred for assessment of exercise-induced respiratory symptoms show objective evidence of exercise-induced bronchospasm.[877] Other diagnoses producing reproducible symptoms on exercise include normal physiological exercise limitation, with and without poor physical fitness, restrictive defect, vocal cord dysfunction, hyperventilation, habit cough, and supraventricular tachycardia.[878]

Most exercise-related wheezing in adolescents can be diagnosed and managed by careful clinical assessment.[879] The absence of other features of asthma and an absent response to pre-treatment with $\beta_2$agonist make exercise-induced asthma unlikely. Exercise testing with cardiac and respiratory monitoring that reproduces the symptoms may be helpful in identifying the specific cause.[878]

Use of questionnaires

When using questionnaires, the prevalence of current symptoms is higher when the adolescent completes the questions rather than the parents, while questions about the last 12 months give similar results between the parents and the adolescent.[880]

In one study in adolescents, internet and written questionnaires about asthma provided equivalent results.[881] The asthma control questionnaire (ACQ) and the asthma control test (ACT) have been validated in adolescents with asthma *(see Table 8)*.[845]

Quality of life measures

Quality of life (QoL) scales (such as AQLQ12+) can be used in adolescents.[882,883]

Lung Function

In adolescents with asthma, tests of airflow obstruction and airway responsiveness may provide support for a diagnosis of asthma. However, most adolescents with asthma have normal lung function despite having symptoms.

Bronchial hyper-reactivity

Although many children with asthma go into long lasting clinical remission at adolescence, bronchial hyper-reactivity (BHR) may persist. Whether persisting BHR reflects ongoing airway inflammation is debated.[886]

A negative response to an exercise test is helpful in excluding asthma in children with exercise-related breathlessness.[878]

7.1.4 RISK FACTORS

There is a body of evidence from epidemiological cohort studies highlighting risk factors for asthma in adolescents.

Atopy

Studies confirm that atopic dermatitis and atopic rhinitis are amongst the factors most strongly associated with asthma persisting into teenage years.[888-891]

Prematurity and early life wheezing

Adolescents who were very low birth weight due to prematurity (as opposed to intrauterine growth retardation) were more prone to chronic cough, wheezing and asthma and showed medium and small airway obstruction compared to matched controls.[892]

Frequent or severe episodes of wheezing in childhood are associated with recurrent wheeze that persists into adolescence.[5,8,13,16,21,26,38,39,891]

Gender

During adolescence there is a reversal of the gender association of asthma with the disease being more prevalent in females than males from 13-14 years onwards.[893] The same change is seen with asthma exacerbations with risk of an asthma admission in females becoming double that observed in males from around 13-14 years.[894] This phenomenon has been attributed to a greater incidence of asthma among teenage girls.[895]

Chlorinated swimming pools

Exposure to chlorinated swimming pools has been associated with an increased risk of asthma, airway inflammation and some respiratory allergies.[896] Such associations were not found among adolescents without atopy or in those who attended copper-silver sanitised pools.[897]

7.1.5 CO-MORBIDITIES AND MODIFIABLE BEHAVIOURS

Anxiety and depressive disorders

Asthma in adolescence is associated with an increased likelihood of major depression, panic attacks and anxiety disorder. This may reflect effects of common factors associated with anxiety and depressive disorders rather than a direct causal link with asthma.[898] In young people with asthma, the presence of an anxiety or depressive disorder is highly associated with increased asthma symptom burden.[899] Depressive symptoms were one risk factor identified in children and adolescents who died of asthma.[900] Assessment of anxiety may help identify individuals who are at risk for poorer asthma specific quality of life.[901]

Clinical conditions associated with anxiety may be mistaken for, or overlap with asthma. These include dysfunctional breathing (hyperventilation syndrome and sighing dyspnoea), vocal cord dysfunction, and psychogenic cough. These conditions can present acutely and may often be frightening to the young person. This may lead to a cycle of bronchodilator overuse, which then further exacerbates the symptoms. Detailed medical assessment with careful attention to the adolescent's personal perceptions and experiences of their symptoms is required to make an accurate diagnosis.[902]

Brief screening questionnaires for anxiety and depression suitable for use in adolescents are available and may help identify those with significant anxiety and depression.[903]

Obesity

The evidence on whether asthma is more common in overweight and obese adolescents with asthma is conflicting.[888,904-906.] While weight reduction in obese adults with asthma improves lung function, symptoms, morbidity and health status, this has not yet been established in adolescents with asthma.

Gastro-oesophageal reflux and gastro-oesophageal reflux disease

Gastro-oesophageal reflux and gastro-oesophageal disease (GORD) is common in asthma patients, including adolescents.[907] A systematic review confirmed an association between GORD and asthma in children and adolescents in secondary and tertiary referral settings. The nature of the association, however, is unclear.[908] There is no evidence that treatment for GORD improves asthma symptoms in children with GORD and asthma.[863,909]

7.1.6 ASTHMA EXACERBATIONS AND THE RISK OF HOSPITAL ADMISSION

Clinical characteristics and markers of severity, including frequent respiratory symptoms, airway hyper-responsiveness, atopy, and low lung function, identify those at high risk of hospitalisation for asthma, particularly with respect to multiple admissions.[910]

7.1.7 LONG TERM OUTLOOK AND ENTRY INTO THE WORK PLACE

Long term follow-up of vocational and working careers found that adolescents and young adults (10-22 years) with relatively mild asthma have slightly more limitations in vocational and professional careers than those without asthma. They had a small increased risk of limitations in daily activity attributable to respiratory health and of absence from work. In the majority, however, the differences amounted to only a few days per year.[911] Young adults with asthma had a low awareness of occupations that might worsen asthma (for example, exposure to dusts, fumes, spray, exertion and temperature changes) and did not generally discuss career plans with their general practitioner. Further details about occupational asthma can be found in section 7.9.

☑ Clinicians should discuss future career choices with adolescents with asthma and highlight occupations that might increase susceptibility to work related asthma symptoms.

7.1.8 NON-PHARMACOLOGICAL MANAGEMENT

Tobacco smoking and environmental exposure to tobacco smoke

Exposure to passive smoking remains a significant health risk.

One study of asthma morbidity among urban (young adolescents mean approximately 11 years of age) found at baseline that 28% of caregivers reported exposure to environmental tobacco smoke (ETS) in the home and 19% reported exposure outside the primary household. Children who received a 20 minute educational intervention about ETS exposure and whose ETS exposure had decreased at follow-up had fewer hospitalisations ($p = 0.034$) and emergency department visits ($p \leq 0.001$) reported in the next 12 months) as well as fewer episodes of poor asthma control ($p = 0.042$).[912]

In a national survey in Denmark, 37.7% of adolescents with asthma smoked currently and 16.5% daily. Smoking was more common in girls. More of those with asthma smoked daily, smoked more cigarettes and had tried to quit smoking.[913] 2+ 3

Among adolescents, smoking is a risk factor for asthma.[889, 914-916] A longitudinal study of asthma and allergic disease in school children in Sweden found that both passive and active smoking were significantly related to asthma and wheeze in adolescents. Maternal ETS exposure was associated with lifetime symptoms, but daily smoking among the adolescents was more strongly related to current symptoms.[917] 4

NICE has recommended that all smokers should be offered a brief intervention about stopping smoking. Young people aged 12-17 years who have a strong commitment to quit smoking should be offered advice on how to stop and encouraged to use local NHS smoking cessation services by providing details on when, where and how to access them.

☑ Adolescents with asthma (and their parents and carers) should be encouraged to avoid exposure to environmental tobacco smoke and should be informed about the risks and urged not to start smoking.

☑ Adolescents with asthma should be asked if they smoke personally. If they do and wish to stop, they should be offered advice on how to stop and encouraged to use local NHS smoking cessation services.

Complementary and alternative medicine

In a small study,16% of Italian teenagers had used complementary and alternative medicine (CAM; (homeopathy, acupuncture, herbal medicines).[918] In a US study, 80% of urban adolescents (aged 13-18 years) with asthma reported that they had used CAM, most commonly rubs, herbal teas, prayer and massage.[919] While most adolescents used CAM with conventional asthma therapy, 27% reported they used it instead of prescribed therapy,[919] suggesting that CAM use may be a marker of non-adherence with prescribed asthma treatment. 2-

☑ Health care professionals should be aware that CAM use is common in adolescents and should ask about its use.

7.1.9 PHARMACOLOGICAL MANAGMENT

Specific evidence about the pharmacological management of adolescents with asthma is limited and is usually extrapolated from paediatric and adult studies. Recommendations for pharmacological management of asthma in children and adults can be found in section 4.

7.1.10 INHALER DEVICES

Specific evidence about inhaler device use and choice in adolescents is limited. Inhaler devices are covered in section 5.

Two small studies comparing two different types of inhalers in adolescents found that both dry powder inhalers (DPI) and pressurised metered dose inhalers (pMDIs) plus spacer are of value in adolescent asthma.[920, 921] There were no differences between the two inhaler devices in terms of symptoms or lung function but patients preferred the DPI. 2+

Though adolescents with asthma may be competent at using their inhaler devices, their actual adherence to treatment may be affected by other factors such as preference. In particular, many adolescents prescribed a pMDI with spacer do not use the spacers as they are felt to be too inconvenient.[922, 923] 3

☑ Adolescent preference for inhaler device should be taken into consideration as a factor in improving adherence to treatment.

☑ As well as checking inhaler technique it is important to enquire about factors that may affect inhaler device use in real life settings such as school.

☑ Consider prescribing a more portable device (as an alternative to a pMDI with spacer) for delivering bronchodilators when away from home.

7.1.11 ORGANISATION AND DELIVERY OF CARE

Health care setting

Very little evidence was identified to determine the best healthcare setting to encourage attendance amongst adolescents with asthma.

A two-year follow-up study found that a multi-disciplinary day programme improved asthma control in a group of adolescents with very severe asthma. This study involved a highly selected group of patients and a wide range of interventions and is not generalisable to most adolescents with asthma.[924] 3

Schools as a setting for healthcare delivery and asthma education

Some innovative approaches have used schools as setting for asthma education and review. One focus has been on healthcare delivery such as school-based clinics. Evidence from a single cluster randomised, controlled trial suggests that school-based, nurse-led asthma clinics increase the uptake of asthma reviews in adolescents from 51% in practice care to 91%.[925] Knowledge of asthma, inhaler techniques and positive attitudes increased and a majority of the adolescents preferred the setting, but there was no improvement in clinical outcomes. This may be because the nurses were not able to change or prescribe treatment (which relied on a separate visit to a doctor).

Other approaches have used schools as a setting for asthma education including peer-led education. In a single, well-conducted RCT peer-led education in schools improved quality of life, asthma control and days off school for adolescents with asthma.[926] In a US study, a randomised trial of a web-based tailored asthma management programme delivered using school computers found that, after 12 months students reported fewer symptoms, school days missed, restricted-activity days, and hospitalisations for asthma than control students. The programme was inexpensive to deliver.[927] 1+

A number of countries, particularly Australia and New Zealand, have developed national programmes to ensure that schools can deliver appropriate first aid and emergency response to students with asthma as well as encouraging participation in sporting activities.[928]

B **School based clinics may be considered for adolescents with asthma to improve attendance.**

B **Peer-led interventions for adolescents in the school setting should be considered.**

☑ Integration of school based clinics with primary care services is essential.

Transition to adult based health care

Transition to adult services is important for all adolescents with asthma, irrespective of the asthma severity. No studies on transition of adolescents with asthma to adult services were identified although there are many studies looking at transition of adolescents with chronic illness. Few studies compare different approaches and many recommendations come from consensus statements rather than randomised, controlled trials.[865-867] In the UK, information on transition is available from the Royal College of Paediatrics and Child Health and Department of Health websites.

It is important that the process of transition is coordinated and it is recommended that a healthcare professional be identified to oversee transition and either link with a counterpart in adult services or remain involved until the young person is settled within adult services.[929, 930]

☑ In the initial period after transition to adult services in secondary care, adolescents are best seen by one consultant to build their confidence and encourage attendance.

Preparation for transition

Transition should be seen as a process and not just the event of transfer to adult services.[929] It should begin early, be planned and involve the young person and be both age and developmentally appropriate *(see Table 13)*.[929]

Table 13: Recommendations for organising transition services[929]

Young people should be given the opportunity to be seen without their parents/carers
Transition services must address the needs of parents/carers whose role in their child's life is evolving at this time
Transition services must be multi-disciplinary and multi-agency. Optimal care requires a cooperative working relationship between adult and paediatric services, particularly where the young person has complex needs with multiple specialty involvement
Coordination of transitional care is critical. There should be an identified coordinator who supports the young person until he or she is settled within the adult system
Young people should be encouraged to take part in transition/support programmes and/or put in contact with other appropriate youth support groups
The involvement of adult physicians prior to transfer supports attendance and adherence to treatment
Transition services must undergo continued evaluation

7.1.12 PATIENT EDUCATION AND SELF-MANAGEMENT

Education in self-management

Section 9 covers self-management education and the components of a self-management programme.

Effective transition care involves preparing adolescents with asthma to take independent responsibility for their own asthma management and enabling them to be able to negotiate the health system effectively *(see Table 14)*. Clinicians need to educate and empower adolescents to manage as much of their asthma care as they are capable of doing while supporting parents gradually to hand over responsibility for management to their child.[931]

Table 14: Specific knowledge, attitudes and skills that underpin independent self-management practices in adolescents with asthma[931]

Can name and explain their condition
Can list their medications, treatments or other management practices (eg special diet)
Can explain why each medication or management practice is necessary
Can remember to take their medications most of the time
Can answer questions asked of them by doctors or health professionals
Can ask questions of their doctor or other health professional
Can arrange (and cancel) appointments
Can consult with a doctor or other health professional without a parent/carers
Remembers to order more medication before it runs out
Can have prescriptions filled at pharmacy
Develops the desire for their healthcare to be independent of their parents/carers
Can prioritise their health over (some) other desires

For adolescents with asthma, the available evidence about self-management is mainly qualitative and provides insight about the concerns adolescents have about their asthma and its management. Adolescents with asthma report embarrassment over using inhalers in front of others, sadness over not being able to take part in normal activities, frustration and anger at the way they are treated by their families (eg being limited in what they are allowed to do, being fussed over by parents). They also report specific anxieties around fear of dying and feeling guilty over the effect their illness has on the rest of the family. They are concerned about needing to rely on someone else when they have a bad asthma attack and that teachers do not know what to do. They stress the importance of support from friends at school, especially those with asthma.[932, 933]

3

Studies of adolescents with chronic illness (including adolescents with asthma) have highlighted factors that adolescents feel are important in delivering education about self-management to them.[934] These included:

- education must be adapted to meet individual needs and repeated and developed as understanding and experience increases and should include emotional support for coping with feelings
- education should be delivered by educators that respect, engage, encourage and motivate the adolescents
- accompanying information, both written and oral, should be personalised rather than general and use non-medical language that adolescents can understand
- education should be delivered in an appropriate and uninterrupted setting and make appropriate use information technology.

3

D **Design of individual or group education sessions delivered by healthcare professionals should address the needs of adolescents with asthma.**

Adherence

Adherence with asthma treatment, and with asthma trigger avoidance is often poor in adolescents. The evidence for poor adherence comes mainly from questionnaire-based and qualitative studies rather than objective electronic monitoring.[935]

When directly asked, most adolescents admit they do not always follow their treatment plans. Reasons for not adhering include both unintentional reasons (confusion about medications and forgetfulness) and intentional reasons (inhalers being ineffective/hard to use; treatment plan too complicated; more important things to do; concern about side-effects; denial; can't be bothered and embarrassment).[923,936] Background factors, such as younger age, family size, exercise and not smoking or drinking alcohol as well as disease-related factors, such as sense of normality, energy and will-power, support from the parents, physicians and nurses, and a positive attitude towards the disease and treatment were related to good reported adherence.[937]

Non-adherence to medication regimens in adolescents has been linked to other health risk behaviours including tobacco, alcohol and drug use and also to depression.[938] Not only are specific behaviours such as smoking, poor adherence to medication regimens or medical review appointments detrimental to asthma control, they also have been highlighted as potential beacons of distress in adolescents.[939] Clinical tools such as the HEADSS (Home, Education/Employment, Activities, Drugs, Sexuality, Suicide/depression) adolescent health screen provide practitioners with an easily usable psychosocial screen.[940]

3

Strategies to improve adherence in adolescents emphasise the importance of focusing on the individual and their lifestyle and using individualised asthma planning and personal goal setting.[941] One study found that once-daily supervised asthma preventer therapy at school improved asthma control and quality of life.[942]

7.2 DIFFICULT ASTHMA

7.2.1 DEFINING AND ASSESSING DIFFICULT ASTHMA

The term difficult asthma generally refers to a clinical situation where a prior diagnosis of asthma exists, and asthma-like symptoms and exacerbations persist, despite prescription of high-dose asthma therapy. There is no universally agreed definition of difficult asthma in children or adults, and specifically at what level of treatment prescription or exacerbation frequency, the term difficult asthma should apply. Consequently there are no precise data on the prevalence of this clinical problem. Previous consensus studies have suggested failure to achieve symptom control despite prescribed high-dose inhaled steroid as a minimum requirement, whilst more recent consensus work has stipulated a treatment level equivalent to at least step 4 *(see section 4.4 and Figures 4, 5 and 6)*, before labelling as "difficult".[485,486]

In this guideline difficult asthma is defined as persistent symptoms and/or frequent exacerbations despite treatment at step 4 or step 5.

Observational uncontrolled studies in subjects with difficult asthma, using multidisciplinary assessment models have identified high rates of alternative or coexistent diagnoses and psychological comorbidity.[29,487-489] These uncontrolled studies, using systematic multidisciplinary assessment and management, have suggested improved outcomes in adults and children, but controlled clinical trials are required. Within this broadly defined group of subjects with difficult asthma, a proportion will have refractory disease, which is relatively resistant to currently available therapies. This group can only be identified after detailed evaluation, including exclusion of alternative causes of persistent symptoms, management of other comorbidities and confirmation of adherence with therapy. 3

D **Patients with difficult asthma should be systematically evaluated, including:**

- **confirmation of the diagnosis of asthma and**
- **identification of the mechanism of persisting symptoms and assessment of adherence with therapy.**

D **This assessment should be facilitated through a dedicated multidisciplinary difficult asthma service, by a team experienced in the assessment and management of difficult asthma.**

7.3 FACTORS CONTRIBUTING TO DIFFICULT ASTHMA

7.3.1 POOR ADHERENCE

Poor adherence with asthma medication is associated with poor asthma outcome in adults and children *(see section 9.2)*. Few studies have addressed this issue in subjects defined as having difficult asthma. In a case control series, poor adherence based on prescription records was identified in 22% of children with difficult to control asthma, though adherence was not reported in the stable controls.[490] In a descriptive study of 100 adult subjects, with a physician diagnosis of 'severe asthma' 28 patients were on > 15 mg prednisolone and of these nine (32%) were found to be non-adherent with prednisolone.[488] There is no published evidence that poor adherence, if identified, can be successfully addressed in this population. 2^+ 3

C **Poor adherence with maintenance therapy should be considered as a possible mechanism in difficult asthma.**

7.3.2 PSYCHOSOCIAL FACTORS

Fatal and near-fatal asthma have been associated with psychosocial dysfunction *(see section 6.1.3)*. Most observational studies[29, 488, 491-494] and a case control study[495] in subjects with difficult asthma have also suggested a high level of psychological morbidity, though this observation has not been universal.[496,497] 3 2^+

A meta-analysis of behavioural adjustment in children suggested increasing 'asthma severity', defined on the basis of treatment requirements was associated with greater behavioural difficulties.[498] The core issue of 'cause and effect' remains unclear; specifically the extent to which persistent asthma symptoms despite aggressive treatment results in psychological morbidity or whether pre-existing psychological morbidity makes asthma difficult to control. 2++

There is a lack of evidence that interventions specifically targeting psychological morbidity in difficult asthma are of benefit. A small proof of concept study targeting depression demonstrated a reduction in oral steroid use[499] and an observational study in 'high-risk' children with asthma suggested potential benefit from joint consultation with a child psychiatrist with an improvement in symptom scores and adherence with therapy.[500] However, a non-blinded randomised intervention study in adults with difficult asthma showed no benefit from a six month nurse-delivered psychoeducational programme.[501] A meta-analysis of psychoeducational interventions in difficult asthma concluded that many of the studies were of poor quality, though there was some evidence of positive effect of psychosocial educational interventions on hospital admissions in adults and children and on symptoms in children. There was not enough evidence to warrant significant changes in clinical practice and little information available on cost effectiveness.[502] 1+ 3

C **Healthcare professionals should be aware that difficult asthma is commonly associated with coexistent psychological morbidity.**

D **Assessment of coexistent psychological morbidity should be performed as part of a difficult asthma assessment. In children this may include a psychosocial assessment of the family.**

7.3.3 DYSFUNCTIONAL BREATHING

Observational uncontrolled studies in subjects with difficult asthma have identified high rates of dysfunctional breathing as an alternative or concomitant diagnosis to asthma causing symptoms.[29,488] It remains unclear what is the best mechanism of identifying and managing this problem. 3

D **Dysfunctional breathing should be considered as part of a difficult asthma assessment.**

7.3.4 ALLERGY

Acute asthma has been associated with IgE dependent sensitisation to indoor allergens.[503] In case control studies, mould sensitisation has been associated with recurrent admission to hospital and oral steroid use[504, 505] and with intensive care unit admissions and respiratory arrest.[506,507] There is no published evidence of any intervention study in this group. Research in this area is required. 2++ 3

C **In patients with difficult asthma and recurrent hospital admission, allergen testing to moulds should be performed.**

7.3.5 MONITORING AIRWAY RESPONSE

Two randomised blinded controlled trials and one open randomised study have supported the use of titrating steroid treatment against sputum eosinophilia in adults with moderate to severe asthma, with greatest benefit seen in patients receiving higher doses of inhaled steroid therapy.[84,86,508] In the study with the largest numbers of patients receiving high dose inhaled steroid treatment, patients who were considered to be poorly adherent with treatment, or had inadequately controlled aggravating factors, such as rhinitis or gastro-oesophageal reflux were specifically excluded.[84] Case series have suggested that sputum induction is safe in patients with difficult to control asthma.[57,509-512] 1+ 1- 3

Controlled studies using FE_{NO} to target treatment have not specifically targeted adults or children with difficult asthma.[85,513,514] 1+

B **In patients with difficult asthma, consider monitoring induced sputum eosinophil counts to guide steroid treatment.**

Revised 2009

7.4 ASTHMA IN PREGNANCY

7.4.1 NATURAL HISTORY AND MANAGEMENT OF STABLE ASTHMA

The majority of women with asthma have normal pregnancies and the risk of complications is small in those with well controlled asthma. Several physiological changes occur during pregnancy that could worsen or improve asthma, but it is not clear which, if any, are important in determining the course of asthma during pregnancy. Pregnancy can affect the course of asthma and asthma and its treatment can affect pregnancy outcomes.

Course of asthma in pregnancy

The natural history of asthma during pregnancy is extremely variable. In a prospective cohort study of 366 pregnancies in 330 women with asthma, the asthma worsened during pregnancy in 35%.[515] 2009 A more recent prospective cohort study of 1,739 pregnant women showed an overall improvement in 23% and deterioration in 30.3%.[807] The conclusions of a meta-analysis of 14 studies is in agreement with the commonly quoted generalisation that during pregnancy about one third of asthma patients experience an improvement in their asthma, one third experience a worsening of symptoms, and one third remain the same.[518] 2009 There is also some evidence that the course of asthma is similar in successive pregnancies.[515,808] A systematic review showed no effect of pregnancy or stage of pregnancy on FEV_1.[809] 1+ 2+

Studies suggest that 11-18% of pregnant women with asthma will have at least one emergency department visit for acute asthma and of these 62% will require hospitalisation.[516,517] Severe asthma is more likely to worsen during pregnancy than mild asthma,[515] but some patients with very severe asthma may experience improvement, whilst symptoms may deteriorate in some patients with mild asthma. 2009 In a large US study, the rates of asthma exacerbation were 13%, 26% and 52% in those with mild, moderate and severe asthma respectively.[807] The corresponding rates of hospitalisation were 2%, 7% and 27%. 2- 2+

2009 A systematic review concluded that, if symptoms do worsen, this is most likely in the second and third trimesters, with the peak in the sixth month.[808] In a large cohort study, the most severe symptoms were experienced by patients between the 24th and 36th week of pregnancy. Thereafter symptoms decreased significantly in the last four weeks and 90% had no asthma symptoms during labour or delivery. Of those who did, only two patients required anything more than inhaled bronchodilators.[515] A further study has confirmed the observation that the last month of pregnancy is the one in which patients are least likely to have an asthma exacerbation.[519] 2+

Effect of asthma on pregnancy

A systematic review has shown that baseline asthma severity does determine what happens to the course of asthma in pregnancy and asthma may affect the risk of adverse outcomes.[521] A cohort study comparing 198 pregnant women with asthma to 198 women without asthma reported that non-atopic patients with asthma tend to have more severe asthma. Pre-eclampsia was also more common in this group. However with adequate surveillance and treatment, pregnancy and delivery complications can be avoided.[520] 2++ 2+

Uncontrolled asthma is associated with many maternal and fetal complications, including hyperemesis, hypertension, pre-eclampsia, vaginal haemorrhage, complicated labour, fetal growth restriction, pre-term birth, increased perinatal mortality, and neonatal hypoxia.[522-525, 807] A large Swedish population based study using record linkage data demonstrated increased risks for pre-term birth, low birth weight, perinatal mortality and pre-eclampsia in women with asthma. The risks for pre-term delivery and low birth weight were higher in women with more severe asthma necessitating admission.[526] 2+

A large prospective cohort study comparing women with moderate and severe asthma with women without asthma found the only significant difference was an increased Caesarean section rate (OR 1.4, 95% CI, 1.1 to 1.8).[807] Logistic regression analysis of the severe group showed an increased risk of gestational diabetes (AOR 3 (95% CI, 1.2 to 7.8)) and pre-term delivery < 37 weeks (AOR 2.2 95% CI, 1.2 to 4.2) but this could have been an effect of corticosteroids. In the Yale asthma study no effect of asthma symptoms or severity was seen on pre-term delivery but oral steroids increased the rate of pre-term delivery and reduced gestation by 2.2 weeks (AOR 1.05 95% CI, 1.01 to1.09).[810] Daily asthma symptoms were associated with an increased risk of fetal growth restriction (AOR 2.25 95% CI, 1.25 to 4.06) and there was a 24% increase with each increased symptom step. This is supported by a systematic review of four studies that concluded asthma exacerbation in pregnancy increases the risk of low birth weight.[811] The RR was 2.54 (95% CI, 1.52 to 4.25) compared to women without asthma. In a large cohort study of 2,123 women with asthma, there was an association of both mean FEV_1 and mean FEV_1 < 80% predicted with gestational hypertension, pre-term delivery < 37 weeks, < 32 weeks and low birth weight.[812]

2009 — 2+, 2++

In contrast, if asthma is well controlled throughout pregnancy there is little or no increased risk of adverse maternal or fetal complications.[515,516] Pregnancy should therefore be an indication to optimise therapy and maximise lung function in order to reduce the risk of acute exacerbation.

2+

2009 — **C** **Monitor pregnant women with moderate/severe asthma closely to keep their asthma well controlled.**

2009 — **B** **Women should be advised of the importance of maintaining good control of their asthma during pregnancy to avoid problems for both mother and baby.**

☑ Advise women who smoke about the dangers for themselves and their babies and give appropriate support to stop smoking.

7.5 MANAGEMENT OF ACUTE ASTHMA IN PREGNANCY

The management of acute asthma in pregnancy may be affected by concerns about harmful effects of medication on the fetus. In a prospective controlled study of 51 pregnant women and 500 non-pregnant women presenting with acute asthma to an emergency department in Boston, USA, pregnant patients with asthma were less likely to receive appropriate treatment with steroids and, as a result, were more likely to experience ongoing exacerbation at two weeks.[527] Available studies give little cause for concern regarding treatment side effects *(see section 7.3)* and the maternal and fetal risks of uncontrolled asthma are much greater than the risks from using conventional asthma medications for management of acute asthma. In the last four confidential enquiries into maternal deaths in the UK (covering 1994-2005) there were seventeen deaths from asthma.[528,529 813,814]

2+

Oxygen should be delivered to maintain saturation 94-98% in order to prevent maternal and fetal hypoxia.[783] When interpreting arterial blood gases in pregnancy it should be remembered that the progesterone-driven increase in minute ventilation may lead to relative hypocapnia and a respiratory alkalosis, and higher PaO_2[815, 816] but oxygen saturations are unaltered.[817] Acidosis is poorly tolerated by the fetus.

2009 — 4

Drug therapy should be given as for a non-pregnant patient with acute asthma, including nebulised β_2 agonists and early administration of steroid tablets.[515, 517, 519, 522, 523] In severe cases, intravenous β_2 agonists, aminophylline, or intravenous bolus magnesium sulphate can be used as indicated.[818]

2009 — 2+

2009 Continuous fetal monitoring should be performed when asthma is uncontrolled or severe, or when fetal assessment on admission is not reassuring. Consideration should be given to early referral to critical care services as impaired ventilatory mechanics in late pregnancy can lower functional residual capacity and may result in earlier oxygen desaturation.[819] Pregnant women may be more difficult to intubate due to anatomical changes especially if they have pre-eclampsia.[820]

2009 C **Give drug therapy for acute asthma as for the non-pregnant patient including systemic steroids and magnesium sulphate.**

2009 D **Deliver high flow oxygen immediately to maintain saturation 94-98%.**

D **Acute severe asthma in pregnancy is an emergency and should be treated vigorously in hospital.**

☑ Continuous fetal monitoring is recommended for severe acute asthma.

2009 ☑ For women with poorly controlled asthma during pregnancy there should be close liaison between the respiratory physician and obstetrician, with early referral to critical care physicians for women with acute severe asthma.

7.6 DRUG THERAPY IN PREGNANCY

2009 In general, the medicines used to treat asthma are safe in pregnancy.[530, 821] A large UK population based case control study found no increased risk of major congenital malformations in children of women receiving asthma treatment in the year before or during pregnancy.[822] The risk of harm to the fetus from severe or chronically under-treated asthma outweighs any small risk from the medications used to control asthma. 2+

2009 B **Counsel women with asthma regarding the importance and safety of continuing their asthma medications during pregnancy to ensure good asthma control.**

7.6.1 β_2 AGONISTS

2009 No significant association has been demonstrated between major congenital malformations or adverse perinatal outcome and exposure to short-acting β_2 agonists.[530, 531,821-823] A prospective study of 259 pregnant patients with asthma who were using bronchodilators compared with 101 pregnant patients with asthma who were not, and 295 control subjects, found no differences in perinatal mortality, congenital abnormalities, prematurity, mean birth weight, apgar scores or labour/delivery complications.[532] A case control study including 2,460 infants exposed to short-acting β_2 agonists found no increased risk of congenital malformations in exposed infants.[807] 2+ 3

2009 With regard to long-acting β_2 agonists (LABAs), evidence from prescription event monitoring suggests that salmeterol is safe in pregnancy[533] and although there are some data on formoterol, numbers are small.[824] Systematic review of studies including 190 exposures to LABA demonstrated no increased risk of congenital malformations, pre-term delivery or pre-eclampsia.[825] A case control study including 156 infants exposed to LABA found no increased risk of major congenital malformations.[822] As in other settings, LABAs should be used with an inhaled corticosteroid, ideally as a combination product.[826] 2+

2009 Data on the use of combination products in pregnancy are scarce although there are no theoretical reasons why these would be more harmful than the same agents given separately. There are some safety data for seretide (salmeterol/fluticasone) but with small numbers.[827]

2009 B **Use short acting β_2 agonists as normal during pregnancy.**

2009 C **Use long acting β_2 agonists (LABA) as normal during pregnancy.**

7.6.2 INHALED STEROIDS

2009 No significant association has been demonstrated between major congenital malformations or adverse perinatal outcome and exposure to inhaled steroids.[530,534-537, 822, 825, 828] A meta-analysis of four studies of inhaled corticosteroid use in pregnancy showed no increase in the rate of major malformations, pre-term delivery, low birth weight or pregnancy-induced hypertension.[829] The UK case control study included 1,429 infants exposed to inhaled steroids and found no increased risk of major congenital malformations.[822] 2⁻ 2⁺ 2⁺⁺

2009 Inhaled anti-inflammatory treatment has been shown to decrease the risk of an acute attack of asthma in pregnancy[519] and the risk of readmission following asthma exacerbation.[517] A randomised placebo controlled trial of inhaled beclometasone versus oral theophylline in moderate asthma in pregnancy showed no difference in the primary outcome of one or more asthma exacerbations resulting in medical intervention, but inhaled beclometasone was better tolerated.[807] 2⁺

B **Use inhaled steroids as normal during pregnancy.**

7.6.3 THEOPHYLLINES

No significant association has been demonstrated between major congenital malformations or adverse perinatal outcome and exposure to methylxanthines.[530,538] 2⁺

For women requiring theophylline to maintain asthma control, measurement of theophylline levels is recommended. Since protein binding decreases in pregnancy, resulting in increased free drug levels, a lower therapeutic range is probably appropriate.[539] 4

C **Use oral and intravenous theophyllines as normal during pregnancy.**

D **Check blood levels of theophylline in acute severe asthma and in those critically dependent on therapeutic theophylline levels.**

7.6.4 STEROID TABLETS

There is much published literature showing that steroid tablets are not teratogenic[522, 530, 540] but a slight concern that they may be associated with oral clefts. Data from several studies have failed to demonstrate this association with first trimester exposure to steroid tablets[540, 830] but one case control study found a significant association, although this increase is not significant if only paired controls are considered.[542] Although one meta-analysis reported an increased risk,[541] a prospective study by the same group found no difference in the rate of major birth defects in prednisolone-exposed and control babies.[541] 2009 A more recent population based case control study revealed a crude odds ratio of corticosteroid exposure from four weeks before through to 12 weeks after conception of 1.7 (95% CI, 1.1-2.6) for cleft lip.[831] Another case control study[822] including 262 exposed infants found no such association, although this was not limited to first trimester exposure. 2⁺ 2⁻

The association is therefore not definite and even if it is real, the benefit to the mother and the fetus of steroids for treating a life threatening disease justify the use of steroids in pregnancy.[524, 815] Moreover, the various studies of steroid exposure include many patients with conditions other than asthma, and the pattern of steroid use was generally as a regular daily dose rather than as short courses, which is how asthma patients would typically receive oral steroids. 2⁺

Prednisolone is extensively metabolized by placental enzymes so only 10% reaches the fetus, making this the oral steroid of choice to treat maternal asthma in pregnancy. Pregnant women with acute asthma exacerbation are less likely to be treated with steroid tablets than non-pregnant women.[527] Failure to administer steroid tablets when indicated increases the risk of ongoing exacerbation and therefore the risk to the mother and her fetus. 2⁺

2009 Some studies have found an association between steroid tablet use and pregnancy-induced hypertension or pre-eclampsia, pre-term labour[520] and fetal growth but severe asthma may be a confounding variable.[832] 2⁺

2009 **C** **Use steroid tablets as normal when indicated during pregnancy for severe asthma. Steroid tablets should never be withheld because of pregnancy. Women should be advised that the benefits of treatment with oral steroids outweigh the risks.**

7.6.5 LEUKOTRIENE RECEPTOR ANTAGONISTS

2009 Data regarding the safety of leukotriene antagonists (LTRA) in pregnancy are limited. Animal studies and post-marketing surveillance for zafirlukast with 28 pregnancies with 20 exposed in the first trimester and montelukast are reassuring.[833] There are animal data of concern for zileuton.[543] A case control study with 96 cases exposed to LTRAs found no increased risk of major malformations between women with asthma exposed to LTRA and women with asthma taking only beta agonists.[832] A systematic review found no increased risk of malformations or pre-term delivery in nine exposed women.[810, 825] 2-, 4, 2+, 2++

2009 **D** **Leukotriene antagonists may be continued in women who have demonstrated significant improvement in asthma control with these agents prior to pregnancy not achievable with other medications.**

7.6.6 CHROMONES

No significant association has been demonstrated between major congenital malformations or adverse perinatal outcome and exposure to chromones.[529, 530,825, 832] 2+

C **Use chromones as normal during pregnancy.**

7.6.7 IMMUNOMODULATION THERAPY

2009 There are as yet no clinical data on the use of omalizumab for moderate-severe allergic asthma in pregnancy. There are some reassuring animal studies re teratogenicity (classed as FDA category B). A registry of pregnancy exposures is being undertaken.

7.7 MANAGEMENT DURING LABOUR

Acute attacks of asthma are very rare in labour, perhaps due to endogenous steroid production. In women receiving steroid tablets there is a theoretical risk of maternal hypothalamic-pituitary-adrenal axis suppression. Women with asthma may safely use all forms of usual labour analgesia.

2009 In some studies there is an association between asthma and an increased Caesarean section rate,[520,544,545] but this may be due to planned Caesarean sections[519] or inductions of labour rather than due to any direct effect of asthma on intrapartum indications. A large prospective cohort study comparing women with moderate and severe asthma with women without asthma found the only significant difference was an increased Caesarean section rate (OR 1.4, 95% CI 1.1-1.8).[807] 2+

Data suggest that the risk of postpartum exacerbation of asthma is increased in women having Caesarean sections.[544] This may relate to the severity of their asthma rather than to the Caesarean section, or to factors such as postoperative pain with diaphragmatic splinting, hypoventilation and atelectasis. Prostaglandin E2 may safely be used for labour inductions.[539] Prostaglandin F2α (carboprost/hemobate®) used to treat postpartum haemorrhage due to uterine atony may cause bronchospasm.[539] Although ergometrine may cause bronchospasm particularly in association with general anaesthesia,[539] this is not a problem encountered when syntometrine (syntocinon/ergometrine) is used for postpartum haemorrhage prophylaxis. 2-, 3

Although suppression of the fetal hypothalamic-pituitary-adrenal axis is a theoretical possibility with maternal systemic steroid therapy, there is no evidence from clinical practice or the literature to support this.[546]

☑ Advise women that acute asthma is rare in labour.

☑ Advise women to continue their usual asthma medications in labour.

☑ In the absence of acute severe asthma, reserve Caesarean section for the usual obstetric indications.

C **If anaesthesia is required, regional blockade is preferable to general anaesthesia in women with asthma.**

☑ Women receiving steroid tablets at a dose exceeding prednisolone 7.5 mg per day for more than two weeks prior to delivery should receive parenteral hydrocortisone 100 mg 6-8 hourly during labour.

D **Use prostaglandin F2α with extreme caution in women with asthma because of the risk of inducing bronchoconstriction.**

7.8 DRUG THERAPY IN BREASTFEEDING MOTHERS

The medicines used to treat asthma, including steroid tablets, have been shown in early studies to be safe to use in nursing mothers.[547] There is less experience with newer agents. Less than 1% of the maternal dose of theophylline is excreted into breast milk.[547] 2+

Prednisolone is secreted in breast milk, but milk concentrations of prednisolone are only 5-25% of those in serum.[351] The proportion of an oral or intravenous dose of prednisolone recovered in breast milk is less than 0.1%.[548-550] For maternal doses of at least 20 mg once or twice daily the nursing infant is exposed to minimal amounts of steroid with no clinically significant risk.[548-550] 2+ 3

C **Encourage women with asthma to breastfeed.**

C **Use asthma medications as normal during lactation, in line with manufacturers' recommendations.**

7.9 OCCUPATIONAL ASTHMA

7.9.1 INCIDENCE

The true frequency of occupational asthma is not known, but under-reporting is likely. Published reports, which come from surveillance schemes, compensation registries or epidemiological studies, estimate that occupational asthma may account for about 9-15% of adult onset asthma.[551-553] It is now the commonest industrial lung disease in the developed world with over 400 reported causes.[554-556] 2++

The diagnosis should be suspected in all adults with symptoms of airflow limitation, and positively searched for in those with high-risk occupations or exposures. Patients with pre-existing asthma aggravated non-specifically by dust and fumes at work (work-aggravated asthma) should be distinguished from those with pre-existing asthma who become additionally sensitised to an occupational agent.

B **In patients with adult onset, or reappearance of childhood asthma, clinicians should be suspicious that there may be an occupational cause.**

7.9.2 AT-RISK POPULATIONS

Several hundred agents have been reported to cause occupational asthma and new causes are reported regularly in the medical literature.

The most frequently reported causative agents include isocyanates, flour and grain dust, colophony and fluxes, latex, animals, aldehydes and wood dust.[557-565]

The workers most commonly reported to occupational asthma surveillance schemes include paint sprayers, bakers and pastry makers, nurses, chemical workers, animal handlers, welders, food processing workers and timber workers. [557,558,560,562-568] 2++

Workers reported to be at increased risk of developing asthma include bakers, food processors, forestry workers, chemical workers, plastics and rubber workers, metal workers, welders, textile workers, electrical and electronic production workers, storage workers, farm workers, waiters, cleaners, painters, dental workers and laboratory technicians.[569-572] 2+

7.9.3 DIAGNOSIS

Occupational asthma should be considered in all workers with symptoms of airflow limitation. The best screening question to ask is whether symptoms improve on days away from work. This is more sensitive than asking whether symptoms are worse at work, as many symptoms deteriorate in the hours after work or during sleep.

☑ Adults with airflow obstruction should be asked:

- Are you better on days away from work?
- Are you better on holiday?

Those with positive answers should be investigated for occupational asthma.

These questions are not specific for occupational asthma and also identify those with asthma due to agents at home (who may improve on holidays), and those who do much less physical exertion away from work.[573]

Occupational asthma can be present when tests of lung function are normal, limiting their use as a screening tool. Asthmatic symptoms improving away from work can produce false negative diagnoses, so further validation is needed.

Serial measurement of peak respiratory flow is the most readily available initial investigation, and the sensitivity and specificity of serial peak flow measurement in the diagnosis of occupational asthma are high.[574-580] 3

Although skin prick tests or blood tests for specific IgE are available, there are few standardized allergens commercially available which limits their use. A positive test denotes sensitisation, which can occur with or without disease. The diagnosis of occupational asthma can usually be made without specific bronchial provocation testing, considered to be the gold standard diagnostic test. The availability of centres with expertise and facilities for specific provocation testing is very limited in the UK and the test itself is time consuming.

As a general observation, the history is more useful in excluding occupational asthma than in confirming it. A significant proportion of workers with symptoms that improve on days away from work or on holiday have been shown by objective tests not to have occupational asthma.[581] Expert histories have poor specificity compared with specific challenge testing. Free histories taken by experts have high sensitivity but their specificity is lower.[582-587] 3

D **In suspected work-related asthma, the diagnosis of asthma should be confirmed using standard objective criteria.**

7.9.4 SENSISTIVITY AND SPECIFICITY OF SERIAL PEAK FLOW MEASUREMENTS

Direct and blinded comparisons of serial peak flow measurement with either specific bronchial provocation testing, or an expert diagnosis based on a combination of other types of evidence, reported consistently high sensitivities and specificities, averaging 80% and 90% respectively.[575-578,580,588,589] 3

Just one computed method of analysis has been reported, with a sensitivity of 75% and a specificity of 94%.[97,590] 2+

Computed analysis of peak flow records has good diagnostic performance, but statistical analysis of serial peak flow measurements appears to be of limited diagnostic value compared to expert interpretation.[578,588,589]

Serial measurements of peak expiratory flow

Measurements should be made every two hours from waking to sleeping for four weeks, keeping treatment constant and documenting times at work.

Minimum standards for diagnostic sensitivity >70% and specificity >85% are:

- At least three days in each consecutive work period
- At least three series of consecutive days at work with three periods away from work (usually about three weeks)
- At least four evenly spaced readings per day.[580]

The analysis is best done with the aid of a criterion-based expert system. Suitable record forms and support are available from www.occupationalasthma.com

D **Objective diagnosis of occupational asthma should be made using serial peak flow measurements, with at least four readings per day.**

7.9.5 NON-SPECIFIC REACTIVITY

Studies of non-specific reactivity are confounded by different methods used, different cut-offs for normality and the interval between last occupational exposure and the performance of the test (increasing time may allow recovery of initial hyper-reactors). Such studies show that non-specific bronchial hyper-reactivity may be normal in 5-40% of specific challenge positive workers. Testing with higher concentrations of methacholine or histamine, at which some people without asthma would react, reduces the number of non-reacting people with occupational asthma, but still leaves some non-reactors. One study showed no additional benefit of non-specific bronchial reactivity measurement over and above a history and specific IgE to inhaled antigens. A normal test of non-specific reactivity is not sufficiently specific to exclude occupational asthma in clinical practice. [576,581,583,586,587,589,591-602] 2++

Changes in non-specific reactivity at and away from work alone have been found to have only moderate sensitivity and specificity for diagnosis. Three studies were identified where at and away from work exposure measurements were attempted. One did not investigate workers further when at work reactivity was normal, limiting its interpretation. Using a 3.2 fold change in reactivity, one study found a sensitivity of 48% and a specificity of 64%. Reducing the required change to twofold increased the sensitivity to 67%, reducing specificity to 54%. A smaller study with 14 workers with occupational asthma showed a sensitivity of 62% and specificity of 78%. [577,589,601] 2-

7.9.6 SPECIFIC BRONCHIAL PROVOCATION TESTING

Specific provocation challenges are usually used as the gold standard for occupational asthma diagnosis making assessments of their diagnostic validity difficult. In addition, there are no standardised methods for many occupational agents. There is also evidence that the threshold exposure increases with time since last exposure, making the tests less sensitive after prolonged absence from work. There are reports of people having non-specific reactions to specific challenges at concentrations likely to be found in the workplace or of negative reactions to specific challenges in workers with otherwise good evidence of occupational asthma when challenge concentrations are confined to levels below occupational exposure standards. [594,597,600,603,604] 4

D **A negative specific bronchial challenge in a worker with otherwise good evidence of occupational asthma is not sufficient to exclude the diagnosis.**

7.10 MANAGEMENT OF OCCUPATIONAL ASTHMA

The aim of management is to identify the cause, remove the worker from exposure, and for the worker to have worthwhile employment.

Complete avoidance of exposure may or may not improve symptoms and bronchial hyper-responsiveness. Both the duration of continued exposure following the onset of symptoms and the severity of asthma at diagnosis may be important determinants of outcome. Early diagnosis and early avoidance of further exposure, either by relocation of the worker or substitution of the hazard offer the best chance of complete recovery. Workers who remain in the same job and continue to be exposed to the same causative agent after diagnosis are unlikely to improve and symptoms may worsen. The likelihood of improvement or resolution of symptoms or of preventing deterioration is greater in workers who have no further exposure to the causative agent. [576,605-613] 2^{++}

Several studies have shown that the prognosis for workers with occupational asthma is worse for those who remain exposed for more than one year after symptoms develop, compared with those removed earlier.[614-616]

D **Relocation away from exposure should occur as soon as diagnosis is confirmed, and ideally within 12 months of the first work-related symptoms of asthma.**

There is consistent evidence from clinical and workforce case series that about one third of workers with occupational asthma are unemployed after diagnosis. It is unclear whether this risk is higher than that for other adults with asthma. [582,617,618] The risk of unemployment may fall with increasing time after diagnosis.[619] There is consistent evidence that loss of employment following a diagnosis of occupational asthma is associated with loss of income. Adults with occupational asthma may find employment more difficult than adults with non-occupational asthma.[617,618] Approximately one third of workers with occupational asthma have been shown to be unemployed up to six years after diagnosis.[582,617-624] 2^{-}

8 Organisation and delivery of care, and audit

8.1 ROUTINE PRIMARY CARE

8.1.1 ACCESS TO ROUTINE PRIMARY CARE

Primary care services delivered by doctors and nurses trained in asthma management improves diagnosis, prescribing, education, monitoring, and continuity of care [625,626] Successful training programmes typically include outreach educational visits to practices or practitioners using interactive educational methods focused around clinical guidelines, occasionally including audit and feedback of care.[625,627,628] 1+

A **All people with asthma should have access to primary care services delivered by doctors and nurses with appropriate training in asthma management.**

❖ *Audit the percentage of clinicians who have taken part in a suitable asthma educational update within last two years.*

8.1.2 STRUCTURED REVIEW

Proactive clinical review of people with asthma improves clinical outcomes. Evidence for benefit is strongest when reviews include discussion and use of a written action plan.[407] Benefits include reduced school or work absence, reduced exacerbation rate, improved symptom control and reduced attendance at the emergency department.[629,630] Proactive structured review, as opposed to opportunistic or unscheduled review, is associated with reduced exacerbation rate and days lost from normal activity.[626,631,632] It is difficult to be prescriptive about the frequency of review as need will vary with the severity of the disease. Outcome is probably similar whether a practice nurse (PN), or a general practitioner (GP) conducts the review. Clinicians trained in asthma management achieve better outcomes for their patients.[626,633,634] 2+ 3 4 1+

A **In primary care, people with asthma should be reviewed regularly by a nurse or doctor with appropriate training in asthma management. Review should incorporate a written action plan.**

❖ *Audit the percentage of patients reviewed annually. Consider focusing on particular groups such as those overusing bronchodilators, patients on higher treatment steps, those with exacerbations or from groups with more complex needs.*

❖ *Audit the percentage of patients receiving action plans. Consider focusing on subgroups listed above.*

READ coding of patients who are newly diagnosed or register at a practice will ensure a meaningful database for audit and review purposes. Specifically identifying patients with high risk asthma (eg those with frequent admissions) in an effort to target more detailed input is logical but supported by limited evidence.[635] Not all patients want regular review, or are willing to attend a pre-arranged appointment. Reviews carried out by telephone may be as effective as those using face-to-face consultations,[636] but face-to-face review will be appropriate for some patients, such as those with poor asthma control or inhaler-related problems. 2++

B **Consider carrying out routine reviews by telephone for people with asthma.**

Asthma clinics in primary care may be a convenient way of delivering care, but there is limited evidence that they themselves improve outcome.[291] Most practices will provide asthma reviews as part of routine appointment sessions. It is what happens during the review consultation that matters.[637-640] Audit that feeds back guidelines recommendations on the management of individual patients may improve outcomes.[641,642]

C **General practices should maintain a register of people with asthma.**

C **Clinical review should be structured and utilise a standard recording system.**

B **Feedback of audit data to clinicians should link guidelines recommendations to management of individual patients.**

The ideal content of an asthma review consultation is uncertain. Discussion and provision of a written action plan leads to improved outcomes.[643] Other activities likely to be important are reviewing understanding of medication role and use, checking inhaler technique, recording lung function. Structured review systems such as the Royal College of Physicians 'Three Key Questions',[109] the Tayside Asthma Stamp,[644] and the modified Jones Morbidity Index[645] improve the recording of relevant data and may prompt a search for causes of suboptimal asthma control, such as under-treatment, poor adherence or poor inhaler technique. However, such tools can lead to a more physician-centred or template-directed consultation. Reviewing patients using a patient-centred style of consultation can lead to improved outcomes.[625]

8.1.3 SHARED CARE

Shared care schemes have been shown to be effective in some healthcare environments. There are no UK studies directly comparing primary and secondary care management, but international work suggests there may be little difference: what is done would appear to be more important than who by or where. [646] 1+ 2+

Integrated care schemes such as Grampian Asthma Study in Integrated Care (GRASSIC) suggest that place of care is not directly linked to clinical outcome.[647-650] Shared care had a similar outcome to outpatient care. Outreach support for primary care by asthma specialist nurses may reduce unscheduled asthma care but only if targeted around follow-up of patients recently attending secondary care with exacerbations. 1+ 2+

Community pharmacists trained in asthma care and teaching self management skills may improve asthma control,[651,652] although evidence is sparse and inconsistent.[653] 1-

8.1.4 PATIENT SUBGROUPS

Ethnic subgroups have adverse clinical outcomes, including higher hospital admission and exacerbation rates.[654,655] In some countries ethnic minority groups have higher death rates due to asthma than do their contemporaries.[656,657] Minority groups describe poorer access to primary care and acute medical care,[658] and compared with majority groups, have a higher use of emergency facilities for routine care.[659] Educating primary care clinicians improves diagnosis, prescribing, education, and continuity of care for minority group children.[659] There is an established link between poor socioeconomic status and adverse asthma outcome.[660-664] 2+ 3 4 1+

Adolescents and the elderly are particularly vulnerable to the adverse effects of asthma. Adolescents and young adults make more frequent use of emergency asthma healthcare services, make less use of structured clinical review services than other age groups, and have high reliance on bronchodilators.[665,666] Asthma in the elderly is a neglected area of research, despite high mortality and morbidity.[391,667,668] 3

D **Healthcare professionals who provide asthma care should have heightened awareness of the complex needs of ethnic minorities, socially disadvantaged groups, adolescents, the elderly and those with communication difficulties.**

❖ *Audit asthma outcomes in relevant subgroups of the population.*

8.2 ACUTE EXACERBATIONS

People with asthma who experience deterioration in symptom control leading to an acute exacerbation can access a wide variety of sources of care. Few studies have looked at the relative merits of one type of service compared to another. Exceptions include a UK study showing a better outcome for patients managed by a specialist respiratory ward compared to a general medical ward, and a US study showing more favourable outcome in patients managed by specialist allergists compared to generalists.[669,670] 2+ 3

C **Manage hospital inpatients with asthma in specialist rather than general units.**

☑ All services involved in the care of acute asthma should be staffed by appropriately trained personnel and have access to all the equipment needed to manage acute asthma.

❖ *Audit the percentage of inpatients receiving care from specialist asthma nurse or chest physician.*

Models of care addressing access such as NHS Direct/NHS 24 produce similar outcomes to routine general practice, but have high referral rates and are unlikely to promote the continuity of care required for longer term management.[671] 3

A structured clinical assessment and a standardised recording system are associated with favourable outcome in acute exacerbations.[672] Audit of the management of patients with acute asthma attacks is associated with improved concordance with recommended guidelines and in turn improved clinical outcome and reduced exacerbation rate.[673-675] 2+ 2- 3

There is no evidence that the publication of guidelines per se improves care: clinicians need to link best practice to the management of individual patients. This effect is apparent in hospital and general practice care.[447] Certain actions, for example early prescription of oral corticosteroids for acute exacerbations of asthma, reduce hospitalisation and relapse rates. Clinicians should refer to relevant chapters in this guideline for advice.

B **Clinicians in primary and secondary care should treat asthma according to recommended guidelines.**

❖ *Audit the percentage of patients treated according to key guideline recommendations.*

Using acute asthma management protocols and clinical pathways can be beneficial and cost effective. Sub-optimal control of asthma leading to exacerbation is more expensive to manage than well controlled asthma.[630] Early discharge schemes from hospital and emergency departments may be cost effective.[445,676] 2+ 3

The safety of telephone help lines has not been established. 'Direct dial' emergency admission schemes may be of benefit to a small group of patients with severe or 'brittle' asthma but there is insufficient evidence to justify their widespread introduction.[677] Admission criteria are discussed elsewhere *(see section 6.2.6)*. 4

Criteria for and timing of discharge from hospital and emergency departments has been studied. The key event in recovery appears to be improved symptoms and peak flow rather than a complete return to normality. Discharge when improvement is apparent may be as safe as discharge when full stability is achieved. Asthma specialist nurse education of adults and school-age (but not pre-school) children at or shortly after hospital attendance improves symptom control, self management and re-attendance rates.[678-683] 1+ 2++ 2+ 2-

Making an appointment for review in primary care prior to discharge improves follow-up rates (but not outcomes).[684] Review within 30 days after hospital attendance with acute asthma is associated with reduced risk of further acute episodes.[685] There is most evidence of benefit when follow up is provided by specialist nurses. Various types of follow up after an acute exacerbation have been evaluated including GP care, hospital outpatient, and telephone follow up.[680,686] There would appear to be little difference in outcome depending on place or personnel involved in follow up *(see section 6.6)*.[676] 3 1+

A **Discharge from hospital or the emergency department should be a planned, supervised event which includes self management planning. It may safely take place as soon as clinical improvement is apparent.**

A **All people attending hospital with acute exacerbations of asthma should be reviewed by a clinician with particular expertise in asthma management, preferably within 30 days.**

❖ *Audit the percentage of people receiving specialist nurse advice including self management planning before discharge.*

❖ *Audit the percentage of people reviewed within 30 days after hospital attendance with acute exacerbation of asthma.*

8.3 AUDIT

Audit is a moderately effective way to improve the process and probably outcome of care.[687] Its impact is increased if combined with other strategies to change clinician behaviour, for example outreach education programmes. Whilst trials of audit in asthma care are few, those showing benefits have tended to incorporate feedback data to clinicians on the process of care such as frequency of review, checking of inhaler technique or lung function measurement. Passive feedback of aggregated data, for instance on prescribing patterns, does not change practice.[688]

8.3.1 TYPES OF AUDIT IN ASTHMA CARE

National or regional audits of asthma deaths have focused attention on delivery of care for severe asthma. Some primary care trusts have PCT-wide programmes of audit which extract practice data electronically and feedback comparative data on process of care, promoting a benchmarking approach to quality improvement.[689] The GMS Quality and Outcomes Framework (QOF) links audit of asthma care to financial incentives. Critical event audit focuses on an adverse event such as an asthma death, or failure of delivery care. How effective these activities are in improving outcomes of asthma care is uncertain.

Common sense suggests that auditing activities shown to improve patient outcomes is worthwhile. This chapter links suggestions for audit to guideline recommendations. Audit datasets are available at www.brit-thoracic.org.uk.

8.3.2 SUMMARY OF RECOMMENDED AUDITS

Diagnosis

Audit the percentage of adults with an Asthma Control Questionnaire score recorded and an Asthma Control Questionnaire of >0.75.

Non-pharmacological management

Audit the percentage of patients and parents-to be with smoking status recorded and the percentage who have received smoking cessation advice.

Pharmacological management

Audit:

- *the percentage of patients with potential adverse effects of treatment, for example, the percentage of children prescribed or using >800 micrograms/day of inhaled beclametasone who are not under the care of a specialist respiratory physician*
- *the percentage of patients in whom there has been documented consideration of downward dose titration for inhaled corticosteroid*
- *the percentage of patients using >800 micrograms/day of inhaled beclametasone without documented consideration of add-on therapy*
- *the percentage of patients in whom there has been documented consideration of downward dose titration for inhaled corticosteroid.*

Inhaler devices

Audit the percentage of patients in whom there is a record of satisfactory inhaler technique.

Audit the percentage of patients using a spacer device for mild to moderately severe exacerbations.

Management of acute asthma

Audit the percentage of patients in whom key steps in the management of acute asthma have been followed, for example, the percentage with a PEF measurement, the percentage with a justified X-ray on admission to hospital, or the percentage receiving corticosteroid tablets in adequate dosage and duration.

Asthma in pregnancy

Audit:

- *the percentage of pregnant women with documented discussion of the need to continue β_2 agonists and inhaled corticosteroid medication in pregnancy*
- *the percentage of pregnant women and partners who smoke with documented advice on smoking cessation.*

Occupational asthma

Audit the number of adults with adult-onset asthma for whom an occupational cause has been considered.

Organisation and delivery of care

Audit:

- *the percentage of clinicians who have taken part in suitable asthma educational update within last two years*
- *the percentage of patients reviewed annually. Consider focusing on particular groups such as those overusing bronchodilators, patients on higher treatment steps, those with exacerbations or from groups with more complex needs*
- *asthma outcomes in relevant subgroups of the population*
- *the percentage of inpatients receiving care from specialist asthma nurse or chest physician*
- *the percentage of patients treated according to key guideline recommendations*
- *the percentage of people receiving specialist nurse advice including self management planning before discharge*
- *the percentage of people reviewed within 30 days after hospital attendance with acute exacerbation of asthma.*

Patient education and self management

Audit the percentage of patients receiving written action plans.

Concordance and compliance

Audit prescription requests to determine compliance.

9 Patient education and self management

9.1 SELF-MANAGEMENT EDUCATION AND PERSONALISED ASTHMA ACTION PLANS

Written personalised action plans as part of self management education have been shown to improve health outcomes for people with asthma.[407,678,679,682,690-710] The evidence is particularly good for those in secondary care with moderate to severe disease, and those who have had recent exacerbations where successful interventions have reduced hospitalisations and emergency department attendances in people with severe asthma.[682,705,711,712] A consistent finding in many studies has been improvement in patient outcomes such as self-efficacy, knowledge and confidence.[690,701-703,709,713-727] 1+

A **Patients with asthma should be offered self-management education that focuses on individual needs, and be reinforced by a written personalised action plan.**

A **Prior to discharge, in-patients should receive written personalised action plans, given by clinicians with expertise in asthma management.**

9.1.1 COMPONENTS OF A SELF MANAGEMENT PROGRAMME

Self management education is a multi-faceted intervention with wide variation in the construction of programmes.[728,729] One systematic review has identified key components associated with beneficial outcome *(see Table 15)*.[730] While self management programmes are effective, individual components are not effective in isolation reinforcing the need to support the provision of personalised action plans with patient education.[728,731] 1+

Successful programmes vary considerably, but encompass:

- Structured education, reinforced with written personal action plans, though the duration, intensity and format for delivery may vary.[690,729]
- Specific advice about recognising loss of asthma control, though this may be assessed by symptoms or peak flows or both.[678,679,690,692,696-698,728,730,732-735]
- Actions, summarised as two or three action points, to take if asthma deteriorates, including seeking emergency help, commencing oral steroids (which may include provision of an emergency course of steroid tablets) recommencing or temporarily increasing inhaled steroids, as appropriate to clinical severity.[730]

Some published studies report long, intensive programmes.[709,736-738] However, there is evidence that short programmes are as effective,[679,739] and that usual care can be raised to a standard that incorporates many of the core elements of the successful extensive programmes.[740,741] 1+

A **Introduce personalised action plans as part of a structured educational discussion.**

Checklist 1. Suggested content for an educational programme/discussion

This checklist is intended as an example, which health professionals should adapt to meet the needs of individual patients and/or carers. The purpose of education is to empower patients and/or carers to undertake self management more appropriately and effectively. Information given should be tailored to individual patient's social, emotional and disease status, and age. Different approaches are needed for different ages.

- Nature of the disease
- Nature of the treatment
- Identify areas where patient most wants treatment to have effect
- How to use the treatment
- Development of self monitoring/self assessment skills
- Negotiation of the personalised action plan in light of identified patient goals
- Recognition and management of acute exacerbations
- Appropriate allergen or trigger avoidance.

9.1.2 SELF MANAGEMENT PROGRAMMES IN SPECIFIC PATIENT GROUPS

A range of different patient populations are included in the trials. It cannot be assumed that a successful intervention in one setting will be feasible or appropriate in another. The greatest benefits are shown in those managed in secondary care.[682,711,712] Primary care studies have also shown benefit,[698,700,702,741] though effects are weaker, perhaps because clinical benefit is harder to demonstrate in people with mild asthma. Innovative approaches to self management education in teenagers (web-based, peer delivered within schools) appear to have more success than more traditional programmes.[699-701,706,709,742-744] A different approach may be needed for pre-school children, many of whom have viral induced wheeze.[683,745,746] There are no studies which specifically address the provision of self-management education to the elderly. Sub group analyses from UK trials have suggested that existing self-management programmes may be of less benefit in ethnic minority groups, but there is a lack of studies evaluating more appropriate interventions.[698,705]

Self management programmes will only achieve better health outcomes if the prescribed asthma treatment is appropriate and within guideline recommendations.[713,717] There is some evidence that ownership of a self management plan may attract better treatment (ie increased steroid provision from attending physicians).[682,698,701]

9.2 COMPLIANCE AND CONCORDANCE

The term compliance embodies a traditional model of prescriptive care which refers to the objectively measured usage of prescribed medication, or frequency of monitoring. Non-compliance may be intentional or unintentional. The term 'concordance' signifies a negotiated agreement between the professional and the patient. Non-concordance describes an inability of both parties to come to an understanding, not merely a failure of the patient to follow the health professional's instructions.[747] Studies which assess whether or not the patient believes that their behaviour is appropriate find correlations between beliefs about illness and medicine and concordance.[748,749] Achieving concordance is likely to improve (though not guarantee) compliance.

9.2.1 COMPLIANCE WITH MONITORING AND TREATMENT

Compliance with regular monitoring with peak flow meters, even in clinical drug trials is poor, with recorded daily use as low as 6%.[750, 751] The lack of evidence supporting long term peak flow monitoring,[647,735,752,753] however, does not negate the use of home charting at critical times: for example, at diagnosis and initial assessment, when assessing response to changes in treatment, as part of a personalised action plan during exacerbations.[735] Comparison should be with the patients' best peak flow (not predicted).[730]

Patients are more likely to under-use than over-use treatment[754-756] and under-use should be considered when there is a failure to control asthma symptoms. Patient self reporting and health care professional assessment both overestimate regular use of prophylactic medication.[754,755,757] Computer repeat-prescribing systems, widely available in general practice, provide a good indication of adherence with prescribed asthma regimens. Electronic monitoring, whilst the most accurate method, is only practical in clinical drug trials.[754]

☑ Computer repeat-prescribing systems provide a useful index of compliance.

☑ Where the patient agrees with the health professional that the action is appropriate compliance is more likely.

9.2.2 INTERVENTIONS TO IMPROVE COMPLIANCE AND CONCORDANCE

Compliance can be improved by simple written instructions and reminders of when to use medication.[758] There is a suggestion in the literature that interventions designed to improve communication between patients and health professionals achieve better programme adherence.[625,737,759] Presenting important information first and repeating it can improve patient recall.[760] Computer,[761] and innovative web-based self management programmes may increase use of regular medication.[762] Within managed care programmes, nurse-led telephone-based self management education supported by written information can increase the use of inhaled steroids.[763,764]

☑ Provide simple, verbal and written instructions and information on drug treatment for patients and carers.

There is insufficient evidence to make clear recommendations on how the broader issues of concordance may be improved. Some practical tips for improving compliance are given in checklist 2.

Checklist 2: Practical tips for improving concordance

Open-ended questions like "If we could make one thing better for your asthma what would it be?" may help to elicit a more patient-centred agenda.

Make it clear you are listening and responding to the patient's concerns and goals.

Reinforce practical information and negotiated treatment plans with written instruction.

Consider reminder strategies.

Recall patients who miss appointments.

9.3 IMPLEMENTATION IN PRACTICE

Successful interventions have been delivered by trained asthma healthcare professionals, in the UK usually doctors and nurses, though a quality improvement programme which trained professionals in asthma self management showed no impact on clinical outcomes.[678,679,690,692,694,765]

Three primary care studies explicitly link the provision of self management education with the facilitation of regular, structured review, consistent with the concept of 'guided self management'. All three increased ownership of personalised action plans and one showed a reduction in episodes of 'speech limiting wheeze'.[631,741,766] 1+

B **Initiatives which encourage regular, structured review explicitly incorporating self management education should be used to increase ownership of personalised action plans.**

9.4 PRACTICAL ADVICE

9.4.1 AVAILABLE RESOURCES

A number of resources are available to support health professionals, including the 'Be in Control' materials produced by Asthma UK. Annex 11 reproduces the Asthma UK personalised action plan available from their website www.asthma.org.uk/control. Additional support and information for patients and carers is also available from the Asthma UK website (www.asthma.org.uk) and their Adviceline run by asthma specialist nurses: 08457 01 02 03 which includes an interpreting service covering 22 languages and Typetalk.

9.4.2 GOOD PRACTICE POINTS

Every asthma consultation is an opportunity to review, reinforce and extend both knowledge and skills. This is true whether the patient is seen in primary care, the accident and emergency department or the outpatient clinic. It is important to recognise that education is a process and not a single event.

☑
- A hospital admission represents a window of opportunity to review self management skills. No patient should leave hospital without a written personalised action plan and the benefit may be greatest at first admission.
- An acute consultation offers the opportunity to determine what action the patient has already taken to deal with the exacerbation. Their self management strategy may be reinforced or refined and the need for consolidation at a routine follow up considered.
- A consultation for an upper respiratory tract infection or other known trigger is an opportunity to rehearse with the patient their self management in the event of their asthma deteriorating.
- Brief simple education linked to patient goals is most likely to be acceptable to patients.

Table 15. Summary of the key components of a personalised action plan (adapted from Gibson et al)[730]

Component of an action plan	Result	Practical considerations
Format of action points: Symptom vs peak flow triggered Standard written instructions Traffic light configuration	 Similar effect Consistently beneficial Not clearly better than standard instructions	Asthma UK action plans include both symptom triggers and peak flow levels at which action should be taken.
Number of action points 2-3 action points 4 action points	 Consistently beneficial Not clearly better than 2-3 points	Usual action points are: PEF <80% best: increase inhaled steroids PEF <60% best: commence oral steroids PEF <40% best: seek urgent medical advice
Peak expiratory flow (PEF) levels Based on percentage personal best PEF Based on percentage predicted PEF	 Consistently beneficial Not consistently better than usual care	Personal best should be assessed once treatment has been optimised and peak flows are stable. Best peak flow should be updated every few years in adults, and more frequently in growing children.
Treatment instructions Individualised using inhaled and oral steroids Individualised using oral steroids only Individualised using inhaled steroids	 Consistently beneficial Insufficient data to evaluate Insufficient data to evaluate	Patients may safely hold an emergency supply of prednisolone tablets for use if their symptoms continue to deteriorate and/or if their peak flow falls to 60% of their best. Increasing inhaled steroids is ineffective if patients are already taking moderate or high doses (≥400 mcg daily) and these patients should be advised to move straight to the oral steroid step. Those on low doses (eg 200 mcg) of inhaled steroids may be advised to increase the dose substantially (eg to 1,200 mcg daily) at the onset of a deterioration.[631] Any patients who have stopped medication should be reminded to recommence their inhaled steroids.

10 The evidence base

10.1 SYSTEMATIC LITERATURE REVIEW

The evidence base for this guideline was synthesised in accordance with SIGN methodology. A systematic review of the literature was carried out using an explicit search strategy devised by a SIGN Information Officer. Databases searched include Medline, Embase and the Cochrane Library. Internet searches were carried out on various websites including the US National Guidelines Clearinghouse. The main searches were supplemented by material identified by individual members of the development group. Each of the selected papers was evaluated by two members of the group using standard SIGN methodological checklists before conclusions were considered as evidence.

The evidence base builds on the reviews carried out for the original (2003) version of the guideline and subsequent updates. See Annex 1 for details of the time period covered for each topic. A copy of the search narrative, including listings of strategies, is available on the SIGN website as part of the supporting material for this guideline.

10.2 RECOMMENDATIONS FOR RESEARCH

The guideline development group was not able to identify sufficient evidence to answer all of the key questions asked in this guideline (*see supporting material on the SIGN website,* **www.sign.ac.uk**) The following areas for further research have been identified:

1. In children below 5 years of age taking inhaled steroids and not adequately controlled are the following interventions of value in terms of:
   a. improving pulmonary function
   b. decreasing symptoms
   c. decreasing exacerbations
      - increasing the dose of inhaled steroids
      - long-acting $ß_2$ agonists
      - short-acting $ß_2$ agonists
      - theophyllines
      - oral $ß_2$ agonists
      - short-acting anticholinergics
      - leukotriene receptor antagonists
      - cromones
      - long-acting anticholinergics (tiotropium).
2. Is there any evidence that high dose step down is more effective than step up in adults and in children below 5 years of age?
3. How should treatment be stepped down?
4. Is there any evidence for differences in the treatment of pre-menstrual asthma?
5. Is there any evidence that treatment of asthma should be different in the elderly?
6. Is there evidence that any medication can be used to prevent asthma developing or becoming established in childhood in the first place (primary prevention)?
7. Is there any evidence for benefit or harm from using steroid alert cards (not limited to asthma)?

8. What role does patient preference play in deciding which inhaler to prescribe?

   a. Does this improve compliance?

   b. Does this improve effectiveness of treatment?

9. Is the cleaning and reuse of placebo inhalers (used in teaching and assessing inhaler technique), compared with single-patient use placebo inhalers, associated with a significant risk of infection?

10. Are there any case reports of cross-infection associated with reuse or sharing of an inhaler device (consider also COPD, other respiratory disease)?

11. What is the evidence for delayed assessment of long term disability following relocation away from occupational exposure?

    Consider the time period of recovery after the causative agent has been removed.

12. In occupational asthma is there a relationship between the interval between the first work related symptom and removal from exposure to the offending agent and the ultimate prognosis?

13. What is the time course of recovery of FEV_1 symptoms and bronchial reactivity following cessation of occupational exposure to the causative agent?

14. In patients with asthma, does self-management education using combination inhalers, compared to usual care/no self-management education, reduce admissions/unscheduled appointments/A&E attendances/acute attacks, or improve asthma-related quality of life/ asthma control/lung function (PF or FEV_1)/enablement/self-efficacy?

10.3 REVIEW AND UPDATING

This guideline was issued in 2011 and sections of the guideline will continue to be updated on an on an annual basis. Any updates to the guideline in the interim period will be noted on the SIGN website: **www.sign.ac.uk**

11 Development of the guideline

11.1 INTRODUCTION

The guideline has been developed by multidisciplinary groups of practising clinicians using a standard methodology based on a systematic review of the evidence. Further details about SIGN and the guideline development methodology are contained in "SIGN 50: A Guideline Developer's Handbook", available at **www.sign.ac.uk**

Development involved the work of ten different multidisciplinary evidence review groups, a steering group and an executive group, chaired jointly by Dr Bernard Higgins on behalf of the BTS and Dr Graham Douglas on behalf of SIGN.

All members of the guideline development group made declarations of interest and further details of these are available on request from the SIGN Executive. Guideline development and literature review expertise, support and facilitation were provided by the SIGN Executive.

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Dr Anne Boyter	*Senior Lecturer, Strathclyde Institute of Pharmacy and Biomedical Sciences, Glasgow*
Dr Steve Cunningham	*Consultant Paediatrician, Royal Hospital for Sick Children, Edinburgh*
Ms Grainne d'Ancona	*Lead Pharmacist for Medicine, Guys and St Thomas' Hospital, London*
Dr John Henderson	*Consultant in Paediatric Respiratory Medicine, Bristol Royal Hospital for Children*
Dr Catherine McDougall	*Paediatric Respiratory Trainee, Royal Hospital for Sick Children, Edinburgh*
Dr Mike McKean	*Consultant in Respiratory Paediatrics, Royal Victoria Infirmary, Newcastle upon Tyne*
Ms Linda Pearce	*Respiratory Nurse Consultant, West Suffolk Hospital*
Dr Savitha Pushparajah	*General Practitioner, London*
Dr Mike Smith	*Consultant Paediatrician, Craigavon Area Group Hospital, Northern Ireland*
Dr Alison Whittaker	*Consultant Physician, Newport Chest Clinic, Gwent*

INHALER DEVICES

Dr John White (Chair)	*Consultant Respiratory Physician, York District Hospital*
Dr Chris Cates	*Senior Research Fellow, St George's, University of London*
Professor Henry Chrystyn	*Head of Pharmacy, University of Huddersfield*
Ms Monica Fletcher	*Chief Executive, Education for Health, Warwick*
Sr Karen Heslop	*Respiratory Nurse Specialist, Royal Victoria Infirmary, Newcastle upon Tyne*
Dr Alex Horsley	*Specialist Registrar, Western General Hospital, Edinburgh*

MANAGEMENT OF ACUTE ASTHMA

Dr Gary Connett (Co-chair)	*Consultant Paediatrician, Southampton General Hospital*
Professor Colin Robertson (Co-chair)	*Consultant in Emergency Medicine, Edinburgh Royal Infirmary*
Dr Richard Chavasse	*Consultant in Respiratory Paediatrics, St Helier Hospital, Surrey*
Dr Graham Douglas	*Consultant Respiratory Physician, Aberdeen Royal Infirmary*
Dr Mike Greenstone	*Consultant Physician, Castle Hill Hospital, East Yorkshire*
Dr Nick Innes	*Consultant in Respiratory and General Medicine, The Ipswich Hospital*
Dr Mark Levy	*General Practitioner, The Kenton Bridge Medical Centre, Middlesex*
Dr Rob Niven	*Senior Lecturer in Respiratory Medicine, Whythenshawe Hospital, Manchester*
Dr Ronan O'Driscoll	*Respiratory Physician, Hope Hospital, Salford*
Dr Ed Paterson	*Specialist Registrar in Respiratory Medicine, Aberdeen Royal Infirmary*
Dr Colin Powell	*Consultant Paediatrician, University Hospital of Wales, Cardiff*
Dr Lindsay Reid	*Specialist Registrar in Emergency Medicine, Edinburgh Royal Infirmary*
Dr Peter Weller	*Consultant Paediatrician (Respiratory Medicine), Birmingham Children's Hospital*

DELIVERY/ ORGANISATION OF CARE

Professor Chris Griffiths (Chair)	*Professor of Primary Care, Institute of Health Science Education, London*
Ms Monica Fletcher	*Chief Executive, Education for Health, Warwick*
Professor David Price	*GPIAG Professor of Primary Care Respiratory Medicine, Foresterhill Health Centre, Aberdeen*
Dr Richard Russell	*Consultant Physician, Heatherwood and Wexham Park Hospitals, Berkshire*

PATIENT EDUCATION, SELF MANAGEMENT AND COMPLIANCE

Dr Hilary Pinnock (Chair)	*General Practitioner, Whitstable Medical Practice, Kent*
Dr Graham Douglas	*Consultant Respiratory Physician, Aberdeen Royal Infirmary*
Mrs Erica Evans	*Care Development Manager, Asthma UK, London*
Dr Liesl Osman	*Senior Research Fellow, Aberdeen Royal Infimary*

SPECIAL SITUATIONS

Difficult asthma

Dr Liam Heaney (Chair)	*Senior Lecturer in Respiratory Medicine, Queens University, Belfast*
Dr Chris Brightling	*Senior Clinical Research Fellow, Glenfield Hospital, Leicester*
Dr Andrew Menzies-Gow	*Consultant Respiratory Physician, Royal Brompton Hospital, London*
Dr Brian Smith	*South Australian State President of the Thoracic Society of Australia*
Dr Nicola Wilson	*Honorary Consultant Paediatrician, Royal Brompton Hospital, London*

Asthma in pregnancy

Dr Cathy Nelson-Piercy (Chair)	*Consultant Obstetric Physician, St Thomas' Hospital, London*
Dr Bernard Higgins	*Consultant Respiratory Physician, Freeman Hospital, Newcastle upon Tyne*
Dr Laura Price	*Research Fellow, Imperial College, London*

Occupational asthma

Dr Sherwood Burge (Chair)	*Consultant Respiratory Physician, Birmingham Heartlands Hospital*
Professor Anthony Frew	*Professor of Allergy and Respiratory Medicine, Brighton General Hospital*

Asthma in adolescents

Dr James Paton (Chair)	*Reader and Honorary Consultant Paediatrician, Royal Hospital for Sick Children, Glasgow*
Miss Ann McMurray	*Asthma Nurse Specialist, Royal Hospital for Sick Children,*
Dr Mitesh Patel	*Medical Research Fellow, Medical Research Institute of New Zealand*
Mrs Iona Paterson	*Cystic Fibrosis Pharmacist, Gartnavel General Hospital, Glasgow*
Dr Donald Payne	*Paediatrician, Princess Margaret Hospital, Western Australia*
Miss Cher Piddock	*Clinical Lead, Care Development Team Asthma UK*

11.4 DISSEMINATION GROUP

Mrs Sheila Edwards	*Chief Executive, British Thoracic Society, London*
Ms Monica Fletcher	*Chief Executive, Education for Health, Warwick*
Dr Bernard Higgins	*Consultant Respiratory Physician, Freeman Hospital, Newcastle upon Tyne*
Dr Steve Holmes	*General Practitioner and Chair, General Practice Airways Group, Somerset*
Dr Roberta James*	Acting Programme Director, SIGN
Dr James Paton	Reader and Honorary Consultant Paediatrician, Royal Hospital for Sick Children, Glasgow
Dr Hilary Pinnock	*General Practitioner, Whitstable Medical Practice, Kent*
Mrs Sally Welham	*Deputy Chief Executive, British Thoracic Society, London*

11.5 SYSTEMATIC LITERATURE REVIEW

The evidence base for this guideline built on the reviews carried out for the original (2003) version of the guideline and subsequent updates.

All searches covered the Cochrane Library, Embase, and Medline. See Annex 1 for details of the time period covered for each topic. A copy of the search narrative, including listings of strategies, is available on the SIGN website as part of the supporting material for this guideline.

11.6 CONSULTATION AND PEER REVIEW

11.6.1 CONSULTATION

The most recent changes to this guideline were presented for discussion in draft form at the Summer Meeting of the British Thoracic Society in June 2010. The draft guideline was also available on the SIGN and BTS websites for a limited period at this stage to allow those unable to attend the meeting to contribute to the development of the guideline.

11.6.2 SPECIALIST REVIEWERS

The guideline was also reviewed in draft form by the following independent expert referees, who were asked to comment primarily on the comprehensiveness and accuracy of interpretation of the evidence base supporting the recommendations in the guideline. SIGN and the BTS are very grateful to all of these experts for their contribution to the guideline.

Dr David A R Boldy	*Consultant Respiratory Physician, Pilgrim Hospital, Boston, Lincolnshire*
Dr Patrick Cadigan	*Registrar of the Royal College of Physicians, London*
Dr Kevin Gruffydd-Jones	*Respiratory Lead, Royal College of General Practitioners, Joint Policy Lead, General Practice Airways Group and General Practitioner, Box Surgery, Wiltshire*
Dr Erica Haines	*Asthma Clinical Lead, Education for Health, Warwick*
Mr Kevin Holton	*Head of Respiratory Programme, Department of Health, London*
Dr Jeremy Hull	*Guidelines Officer, British Paediatric Respiratory Society, London*
Dr Duncan Keeley	*General Practitioner, Thame Health Centre, Oxon*

Ms Anna Murphy	*Consultant Respiratory Pharmacist, University Hospitals of Leicester*
Dr Ron Neville	*General Practitioner, Westgate Health Centre, Dundee*
Dr John O'Reilly	*Consultant Physician, Aintree Chest Centre, Liverpool*
Professor Mike Pearson	*Professor of Clinical Evaluation, University of Liverpool*
Dr Robert Scott-Jupp	*Consultant Paediatrician, Salisbury District Hospital*
Dr Anne Thomson	*Consultant in Paediatric Medicine, John Radcliffe Hospital, Oxford*
Professor Neil C Thomson	*Professor of Respiratory Medicine, Gartnavel General Hospital, Glasgow*
Dr Mark Woodhead	*Consultant in General and Respiratory Medicine, Central Manchester and Manchester Children's University Hospitals*

The following organisations also commented

Primary Care Respiratory Society UK

Royal College of Paediatrics and Child Health, London

11.6.3 SIGN EDITORIAL GROUP

As a final quality control check, the guideline is reviewed by an editorial group to ensure that the specialist reviewers' comments have been addressed adequately and that any risk of bias in the guideline development process as a whole has been minimised. All members of the Editorial group make declarations of interest and further details of these are available on request from the SIGN Executive. The editorial group for this guideline was as follows.

Dr Keith Brown	*Chair of SIGN; Co-Editor*
Dr Lorna Thompson	*SIGN Programme Manager*
Dr Sara Twaddle	*Director of SIGN; Co-Editor*

Abbreviations

ABG arterial blood gas

ABPA allergic bronchopulmonary aspergillosis

ACQ Asthma Control Questionairre

ACT Asthma Control Test

ACTH adrenocorticotropic hormone

AQLQ Asthma Quality of Life Questionnaire

AQLQ12+ Asthma Quality of Life Questionnaire 12+

BDP beclometasone

BHR bronchial hyper-reactivity

BTS British Thoracic Society

CAM Complementary and alternative medicine

COPD chronic obstructive pulmonary disease

CXR chest X-ray

DPI dry powder inhaler

ED emergency department

ETS environmental tobacco smoke

FENO exhaled nitric oxide concentration

FEV_1 forced expiratory volume in one second

FVC forced vital capacity

GMS General Medical Services

GORD gastro-oesophageal reflux disease

GP general practitioner

GRASSIC Grampian Asthma Study in Integrated Care

HDU high dependency unit

HEADSS Home, Education/ Employment, Activity, Drugs, Sexuality, Suicide/ depression

HFA hydrofluroalkane

ICS inhaled corticosteroids

ICU intensive care unit

IM intramuscular

IOS impulse oscillometry

LABA long-acting β_2 agonist

MDI metered dose inhaler

MHRA Medicines and Healthcare products Regulatory Agency

n-3PUFA omega-3 polyunsaturated fatty acid

NICE National Institute for Health and Clinical Excellence

NIV non-invasive ventilation

NSAIDS Non-steroidal anti-inflammatory drugs

PAQLQ Paediatric Asthma Quality of Life Questionnaire

PaCO2 partial pressure of carbon dioxide in arterial blood

PaO2 partial pressure of oxygen in arterial blood

PC20 the provocative concentration of bronchoconstrictor (eg methacholine) required to cause a 20% fall in FEV_1

PD20 the provocative dose of bronchoconstrictor (eg methacholine) required to cause a 20% fall in FEV_1

PEF peak expiratory flow

PEF A%H peak expiratory flow amplitude percent highest

PICU paediatric intensive care unit

PN practice nurse

ppb parts per billion

QOF Quality and Outcomes Framework

QOL Quality of life

RCP Royal College of Physicians

RCT randomised controlled trial

RV residual volume

SIGN Scottish Intercollegiate Guidelines Network

SpO_2 saturation of peripheral oxygen

sRaw specific airways resistance

VEmax ventilation at maximal exercise capacity

WHO World Health Organisation

Annex 1

Summary of search histories by section

Literature searches to support the various sections of this guideline are conducted on a rolling basis. This summary indicates the currency of the searches supporting each section. Searches in all databases began with the earliest year available at that time, which varied from database to database; for example, searches in Embase extended back to 1980 and in CINAHL to 1982. Specific date coverage is provided for Medline. Detailed search strategies are available on the SIGN website in the supplementary material section.

Section 2 Diagnosis

Diagnosis in children

The search was last updated in April 2007. Coverage in Medline extends from 2003-2006.This search supplemented the broader search on diagnosis conducted for the original 2003 diagnosis section.

Diagnosis in adults; monitoring

The search was last updated in February 2010. Coverage in Medline extends from 1966-2009.

Section 3 Non-pharmacological management

The search was last updated in February 2006. Coverage in Medline extends from 1966-2005.

Section 4 Pharmacological management

The search was last updated in February 2010. Coverage in Medline extends from 1966-December 2009.

Section 5 Inhaler devices

The search was last updated in June 2008. Coverage in Medline extends from 1998-January 2008.

Section 6 Management of acute asthma

The search was last updated in June 2008. Coverage in Medline extends from 1966-2008.

Section 7 Special situations

Asthma in adolescents

The search was last carried out in February 2010. Coverage in Medline extends from 2001-February 2010.

Difficult asthma

The search was conducted in July 2007 and covered 1996-June 2007.

Asthma in pregnancy

The search was last updated in June 2008. Coverage in Medline extends from 1966-January 2008.

Occupational asthma

The search was last updated by SIGN in March 2003. In 2005, a systematic review by the British Occupational Health Research Foundation was used as the basis for updating this section.

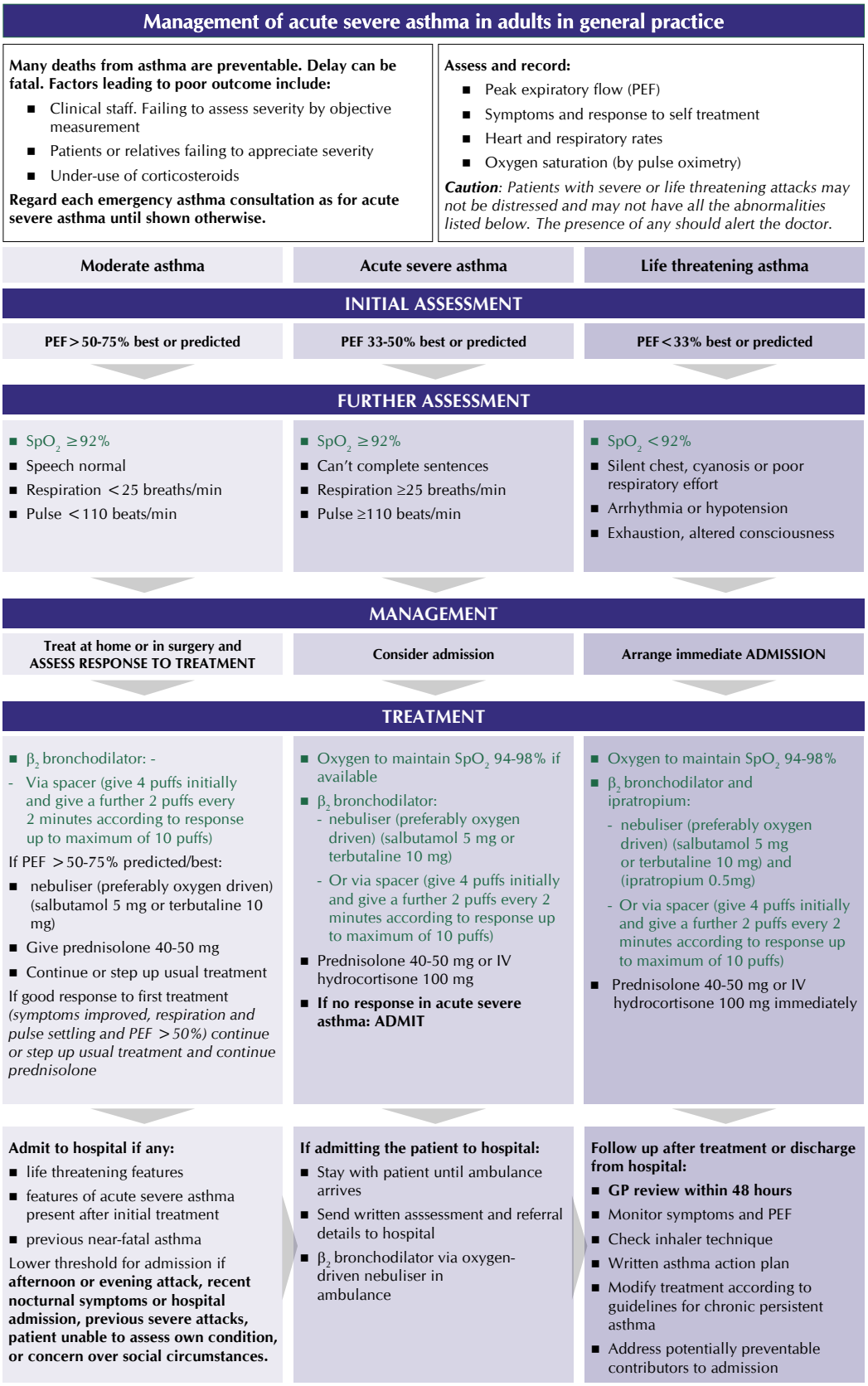
Section 8 Organisation and delivery of care, and audit

The search was last updated in March 2003. Coverage in Medline extends from 1966-2003.

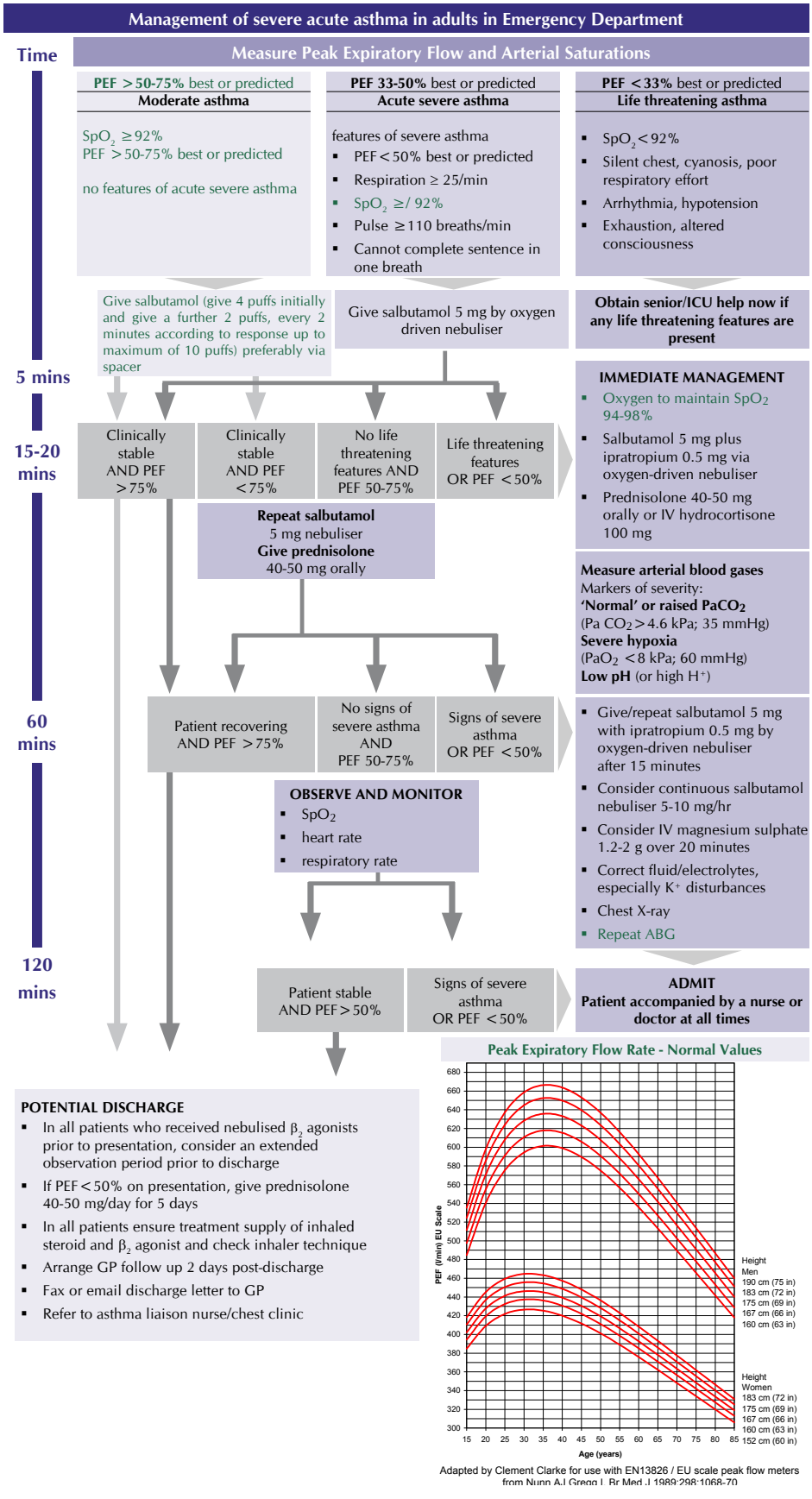
Section 9 Patient education and self management

The search was last updated in February 2006. Coverage in Medline extends from 1966-2005.

Annex 2


Management of acute severe asthma in adults in general practice
Many deaths from asthma are preventable. Delay can be fatal. Factors leading to poor outcome include:
Clinical staff. Failing to assess severity by objective measurement
Patients or relatives failing to appreciate severity
Under-use of corticosteroids
Regard each emergency asthma consultation as for acute severe asthma until shown otherwise.
Assess and record:
Peak expiratory flow (PEF)
Symptoms and response to self treatment
Heart and respiratory rates
Oxygen saturation (by pulse oximetry)
Caution: Patients with severe or life threatening attacks may not be distressed and may not have all the abnormalities listed below. The presence of any should alert the doctor.
Moderate asthma
Acute severe asthma
Life threatening asthma
INITIAL ASSESSMENT
PEF > 50-75% best or predicted
PEF 33-50% best or predicted
PEF < 33% best or predicted
FURTHER ASSESSMENT
SpO2 ≥ 92%
Speech normal
Respiration < 25 breaths/min
Pulse < 110 beats/min
SpO2 ≥ 92%
Can't complete sentences
Respiration ≥25 breaths/min
Pulse ≥110 beats/min
SpO2 < 92%
Silent chest, cyanosis or poor respiratory effort
Arrhythmia or hypotension
Exhaustion, altered consciousness
MANAGEMENT
Treat at home or in surgery and ASSESS RESPONSE TO TREATMENT
Consider admission
Arrange immediate ADMISSION
TREATMENT
β2 bronchodilator: -
- Via spacer (give 4 puffs initially and give a further 2 puffs every 2 minutes according to response up to maximum of 10 puffs)
If PEF > 50-75% predicted/best:
nebuliser (preferably oxygen driven) (salbutamol 5 mg or terbutaline 10 mg)
Give prednisolone 40-50 mg
Continue or step up usual treatment
If good response to first treatment (symptoms improved, respiration and pulse settling and PEF > 50%) continue or step up usual treatment and continue prednisolone
Oxygen to maintain SpO2 94-98% if available
β2 bronchodilator:
- nebuliser (preferably oxygen driven) (salbutamol 5 mg or terbutaline 10 mg)
- Or via spacer (give 4 puffs initially and give a further 2 puffs every 2 minutes according to response up to maximum of 10 puffs)
Prednisolone 40-50 mg or IV hydrocortisone 100 mg
If no response in acute severe asthma: ADMIT
Oxygen to maintain SpO2 94-98%
β2 bronchodilator and ipratropium:
- nebuliser (preferably oxygen driven) (salbutamol 5 mg or terbutaline 10 mg) and (ipratropium 0.5mg)
- Or via spacer (give 4 puffs initially and give a further 2 puffs every 2 minutes according to response up to maximum of 10 puffs)
Prednisolone 40-50 mg or IV hydrocortisone 100 mg immediately
Admit to hospital if any:
life threatening features
features of acute severe asthma present after initial treatment
previous near-fatal asthma
Lower threshold for admission if afternoon or evening attack, recent nocturnal symptoms or hospital admission, previous severe attacks, patient unable to assess own condition, or concern over social circumstances.
If admitting the patient to hospital:
Stay with patient until ambulance arrives
Send written asssessment and referral details to hospital
β2 bronchodilator via oxygen-driven nebuliser in ambulance
Follow up after treatment or discharge from hospital:
GP review within 48 hours
Monitor symptoms and PEF
Check inhaler technique
Written asthma action plan
Modify treatment according to guidelines for chronic persistent asthma
Address potentially preventable contributors to admission

Annex 3


Management of severe acute asthma in adults in Emergency Department
Time
Measure Peak Expiratory Flow and Arterial Saturations
PEF >50-75% best or predicted
Moderate asthma
SpO2 ≥92%
PEF >50-75% best or predicted
no features of acute severe asthma
PEF 33-50% best or predicted
Acute severe asthma
features of severe asthma
PEF <50% best or predicted
Respiration ≥ 25/min
SpO2 ≥/ 92%
Pulse ≥110 breaths/min
Cannot complete sentence in one breath
PEF <33% best or predicted
Life threatening asthma
SpO2 <92%
Silent chest, cyanosis, poor respiratory effort
Arrhythmia, hypotension
Exhaustion, altered consciousness
Give salbutamol (give 4 puffs initially and give a further 2 puffs, every 2 minutes according to response up to maximum of 10 puffs) preferably via spacer
Give salbutamol 5 mg by oxygen driven nebuliser
Obtain senior/ICU help now if any life threatening features are present
5 mins
15-20 mins
Clinically stable AND PEF >75%
Clinically stable AND PEF <75%
No life threatening features AND PEF 50-75%
Life threatening features OR PEF <50%
IMMEDIATE MANAGEMENT
Oxygen to maintain SpO2 94-98%
Salbutamol 5 mg plus ipratropium 0.5 mg via oxygen-driven nebuliser
Prednisolone 40-50 mg orally or IV hydrocortisone 100 mg
Repeat salbutamol 5 mg nebuliser
Give prednisolone 40-50 mg orally
Measure arterial blood gases
Markers of severity:
'Normal' or raised PaCO2
(Pa CO2 >4.6 kPa; 35 mmHg)
Severe hypoxia
(PaO2 <8 kPa; 60 mmHg)
Low pH (or high H+)
60 mins
Patient recovering AND PEF >75%
No signs of severe asthma AND PEF 50-75%
Signs of severe asthma OR PEF <50%
Give/repeat salbutamol 5 mg with ipratropium 0.5 mg by oxygen-driven nebuliser after 15 minutes
Consider continuous salbutamol nebuliser 5-10 mg/hr
Consider IV magnesium sulphate 1.2-2 g over 20 minutes
Correct fluid/electrolytes, especially K+ disturbances
Chest X-ray
Repeat ABG
OBSERVE AND MONITOR
SpO2
heart rate
respiratory rate
120 mins
Patient stable AND PEF >50%
Signs of severe asthma OR PEF <50%
ADMIT
Patient accompanied by a nurse or doctor at all times
POTENTIAL DISCHARGE
In all patients who received nebulised β2 agonists prior to presentation, consider an extended observation period prior to discharge
If PEF <50% on presentation, give prednisolone 40-50 mg/day for 5 days
In all patients ensure treatment supply of inhaled steroid and β2 agonist and check inhaler technique
Arrange GP follow up 2 days post-discharge
Fax or email discharge letter to GP
Refer to asthma liaison nurse/chest clinic
Peak Expiratory Flow Rate - Normal Values
PEF (l/min) EU Scale
680
660
640
620
600
580
560
540
520
500
480
460
440
420
400
380
360
340
320
300
15 20 25 30 35 40 45 50 55 60 65 70 75 80 85
Age (years)
Height
Men
190 cm (75 in)
183 cm (72 in)
175 cm (69 in)
167 cm (66 in)
160 cm (63 in)
Height
Women
183 cm (72 in)
175 cm (69 in)
167 cm (66 in)
160 cm (63 in)
152 cm (60 in)
Adapted by Clement Clarke for use with EN13826 / EU scale peak flow meters
from Nunn AJ Gregg I. Br Med J 1989;298:1068-70

Annex 4

Management of acute severe asthma in adults in hospital

Features of acute severe asthma

- Peak expiratory flow (PEF) 33-50% of best (use % predicted if recent best unknown)
- Can't complete sentences in one breath
- Respirations ≥25 breaths/min
- Pulse ≥110 beats/min

Life threatening features

- PEF <33% of best or predicted
- SpO_2 <92%
- Silent chest, cyanosis, or feeble respiratory effort
- Arrhythmia or hypotension
- Exhaustion, altered consciousness

If a patient has any life threatening feature, measure arterial blood gases. No other investigations are needed for immediate management.

Blood gas markers of a life threatening attack:

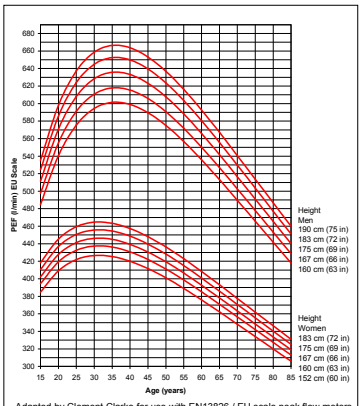
- 'Normal' (4.6-6 kPa, 35-45 mmHg) $PaCO_2$
- Severe hypoxia: PaO_2 <8 kPa (60mmHg) irrespective of treatment with oxygen
- A low pH (or high H^+)

Caution: Patients with severe or life threatening attacks may not be distressed and may not have all these abnormalities. The presence of any should alert the doctor.

Near fatal asthma

- Raised $PaCO_2$
- Requiring mechanical ventilation with raised inflation pressures

Peak Expiratory Flow Rate - Normal Values



Adapted by Clement Clarke for use with EN13826 / EU scale peak flow meters from Nunn AJ Gregg I, Br Med J 1989:298;1068-70

IMMEDIATE TREATMENT

- Oxygen to maintain SpO_2 94-98%
- Salbutamol 5 mg or terbutaline 10 mg via an oxygen-driven nebuliser
- Ipratropium bromide 0.5 mg via an oxygen-driven nebuliser
- Prednisolone tablets 40-50 mg or IV hydrocortisone 100 mg
- No sedatives of any kind
- Chest X ray if pneumothorax or consolidation are suspected or patient requires mechanical ventilation

IF LIFE THREATENING FEATURES ARE PRESENT:

- Discuss with senior clinician and ICU team
- Consider IV magnesium sulphate 1.2-2 g infusion over 20 minutes (unless already given)
- Give nebulised β_2 agonist more frequently e.g. salbutamol 5 mg up to every 15-30 minutes or 10 mg per hour via continuous nebulisation (requires special nebuliser)

SUBSEQUENT MANAGEMENT

IF PATIENT IS IMPROVING continue:

- Oxygen to maintain SpO_2 94-98%
- Prednisolone 40-50mg daily or IV hydrocortisone 100 mg 6 hourly
- Nebulised β_2 agonist and ipratropium 4-6 hourly

IF PATIENT NOT IMPROVING AFTER 15-30 MINUTES:

- Continue oxygen and steroids
- Use continuous nebulisation of salbutamol at 5-10 mg/hour if an appropriate nebuliser is available. Otherwise give nebulised salbutamol 5 mg every 15-30 minutes
- Continue ipratropium 0.5 mg 4-6 hourly until patient is improving

IF PATIENT IS STILL NOT IMPROVING:

- Discuss patient with senior clinician and ICU team
- Consider IV magnesium sulphate 1.2-2 g over 20 minutes (unless already given)
- Senior clinician may consider use of IV β_2 agonist or IV aminophylline or progression to mechanical ventilation

MONITORING

- Repeat measurement of PEF 15-30 minutes after starting treatment
- Oximetry: maintain SpO_2 >94-98%
- Repeat blood gas measurements within 1 hour of starting treatment if:
  - initial PaO_2 <8 kPa (60 mmHg) unless subsequent SpO_2 >92%
  - $PaCO_2$ normal or raised
  - patient deteriorates
- Chart PEF before and after giving β_2 agonists and at least 4 times daily throughout hospital stay

Transfer to ICU accompanied by a doctor prepared to intubate if:

- Deteriorating PEF, worsening or persisting hypoxia, or hypercapnea
- Exhaustion, altered consciousness
- Poor respiratory effort or respiratory arrest

DISCHARGE

When discharged from hospital, patients should have:

- Been on discharge medication for 12-24 hours and have had inhaler technique checked and recorded
- PEF >75% of best or predicted and PEF diurnal variability <25% unless discharge is agreed with respiratory physician
- Treatment with **oral and inhaled steroids** in addition to bronchodilators
- Own PEF meter and **written asthma action plan**
- GP follow up arranged within 2 working days
- Follow up appointment in respiratory clinic within 4 weeks

Patients with severe asthma (indicated by need for admission) **and adverse behavioural or psychosocial features are at risk of further severe or fatal attacks**

- Determine reason(s) for exacerbation and admission
- Send details of admission, discharge and potential best PEF to GP

Annex 5

Management of acute asthma in children in general practice

Age 2-5 years

ASSESS ASTHMA SEVERITY

Moderate asthma	Severe asthma	Life threatening asthma
■ SpO_2 ≥92% ■ Able to talk ■ Heart rate ≤140/min ■ Respiratory rate ≤40/min	■ SpO_2 <92% ■ Too breathless to talk ■ Heart rate >140/min ■ Respiratory rate >40/min ■ Use of accessory neck muscles	SpO_2 <92% plus any of: ■ Silent chest ■ Poor respiratory effort ■ Agitation ■ Altered consciousness ■ Cyanosis
■ β_2 agonist 2-10 puffs via spacer ± facemask ■ Consider soluble prednisolone 20 mg	■ Oxygen via face mask ■ 2-10 puffs of β_2 agonist [give 2 puffs, every 2 minutes according to response up to maximum of 10 puffs] or nebulised salbutamol 2.5 mg or terbutaline 5 mg ■ Soluble prednisolone 20 mg	■ Oxygen via face mask ■ Nebulise: - salbutamol 2.5 mg *or* terbutaline 5 mg + - ipratropium 0.25 mg ■ Soluble prednisolone 20 mg *or* IV hydrocortisone 50 mg
Increase β_2 agonist dose by 2 puffs every 2 minutes according to response up to 10 puffs	**Assess response to treatment 15 mins after β_2 agonist**	
IF POOR RESPONSE ARRANGE ADMISSION	**IF POOR RESPONSE REPEAT β_2 AGONIST AND ARRANGE ADMISSION**	**REPEAT β_2 AGONIST VIA OXYGEN-DRIVEN NEBULISER WHILST ARRANGING IMMEDIATE HOSPITAL ADMISSION**

GOOD RESPONSE
- Continue β_2 agonist via spacer or nebuliser, as needed but not exceeding 4-hourly
- **If symptoms are not controlled repeat β_2 agonist and refer to hospital**
- Continue prednisolone for up to 3 days
- Arrange follow-up clinic visit

POOR RESPONSE
- Stay with patient until ambulance arrives
- Send written assessment and referral details
- Repeat β_2 agonist via oxygen-driven nebuliser in ambulance

LOWER THRESHOLD FOR ADMISSION IF:
- Attack in late afternoon or at night
- Recent hospital admission or previous severe attack
- Concern over social circumstances or ability to cope at home

NB: If a patient has signs and symptoms across categories, always treat according to their most severe features

Age >5 years

ASSESS ASTHMA SEVERITY

Moderate asthma	Severe asthma	Life threatening asthma
■ SpO_2 ≥92% ■ PEF ≥50% best or predicted ■ Able to talk ■ Heart rate ≤125/min ■ Respiratory rate ≤30/min	■ SpO_2 <92% ■ PEF 33-50% best or predicted ■ Too breathless to talk ■ Heart rate >125/min ■ Respiratory rate >30/min ■ Use of accessory neck muscles	SpO_2 <92% plus any of: ■ PEF <33% best or predicted ■ Silent chest ■ Poor respiratory effort ■ Agitation ■ Altered consciousness ■ Cyanosis
■ β_2 agonist 2-10 puffs via spacer ■ Consider soluble prednisolone 30-40 mg	■ Oxygen via face mask ■ 2-10 puffs of β_2 agonist [give 2 puffs, every 2 minutes according to response up to maximum of 10 puffs] or nebulised salbutamol 2.5-5 mg or terbutaline 5-10 mg ■ Soluble prednisolone 30-40 mg	■ Oxygen via face mask ■ Nebulise: - salbutamol 5 mg *or* terbutaline 10 mg + - ipratropium 0.25 mg ■ Soluble prednisolone 30-40 mg *or* IV hydrocortisone 100 mg
Increase β_2 agonist dose by 2 puffs every 2 minutes according to response up to 10 puffs	**Assess response to treatment 15 mins after β_2 agonist**	
IF POOR RESPONSE ARRANGE ADMISSION	**IF POOR RESPONSE REPEAT β_2 AGONIST AND ARRANGE ADMISSION**	**REPEAT β_2 AGONIST VIA OXYGEN-DRIVEN NEBULISER WHILST ARRANGING IMMEDIATE HOSPITAL ADMISSION**

GOOD RESPONSE
- Continue β_2 agonist via spacer or nebuliser, as needed but not exceeding 4-hourly
- **If symptoms are not controlled repeat β_2 agonist and refer to hospital**
- Continue prednisolone for up to 3 days
- Arrange follow-up clinic visit

POOR RESPONSE
- Stay with patient until ambulance arrives
- Send written assessment and referral details
- Repeat β_2 agonist via oxygen-driven nebuliser in ambulance

LOWER THRESHOLD FOR ADMISSION IF:
- Attack in late afternoon or at night
- Recent hospital admission or previous severe attack
- Concern over social circumstances or ability to cope at home

NB: If a patient has signs and symptoms across categories, always treat according to their most severe features

Annex 6

Management of acute asthma in children in Emergency Department

Age 2-5 years

ASSESS ASTHMA SEVERITY

Moderate asthma	Severe asthma	Life threatening asthma
▪ SpO_2 ≥92% ▪ No clinical features of severe asthma **NB: If a patient has signs and symptoms across categories, always treat according to their most severe features**	▪ SpO_2 <92% ▪ Too breathless to talk or eat ▪ Heart rate >140/min ▪ Respiratory rate >40/min ▪ Use of accessory neck muscles	SpO_2 <92% plus any of: ▪ Silent chest ▪ Poor respiratory effort ▪ Agitation ▪ Altered consciousness ▪ Cyanosis
	Oxygen via face mask/nasal prongs to achieve SpO_2 94-98%	
▪ β_2 agonist 2-10 puffs via spacer ± facemask [given one at a time single puffs, tidal breathing and inhaled separately] ▪ Increase β_2 agonist dose by 2 puffs every 2 minutes up to 10 puffs according to response ▪ Consider soluble oral prednisolone 20 mg	▪ β_2 agonist 10 puffs via spacer ± facemask or nebulised salbutamol 2.5 mg or terbutaline 5 mg ▪ Soluble prednisolone 20 mg or IV hydrocortisone 4 mg/kg ▪ Repeat β_2 agonist up to every 20-30 minutes according to response ▪ **If poor response** add 0.25 mg nebulised ipratropium bromide	▪ Nebulised β_2 agonist: salbutamol 2.5 mg or terbutaline 5 mg **plus** ipratropium bromide 0.25 mg nebulised ▪ Oral prednisolone 20mg or IV Hydrocortisone 4mg/kg if vomiting **Discuss with senior clinician, PICU team or paediatrician** ▪ Repeat bronchodilators every 20-30 minutes
Reassess within 1 hour		

DISCHARGE PLAN
- Continue β_2 agonist 4 hourly prn
- Consider prednisolone 20 mg daily for up to 3 days
- Advise to contact GP if not controlled on above treatment
- Provide a written asthma action plan
- Review regular treatment
- Check inhaler technique
- Arrange GP follow up

Arrange immediate transfer to PICU/HDU if poor response to treatment

Admit all cases if features of severe exacerbation persist after initial treatment

Age >5 years

ASSESS ASTHMA SEVERITY

Moderate asthma	Severe asthma	Life threatening asthma
▪ SpO_2 ≥92% ▪ PEF ≥50% best or predicted ▪ No clinical features of severe asthma **NB: If a patient has signs and symptoms across categories, always treat according to their most severe features**	▪ SpO_2 <92% ▪ PEF 33-50% best or predicted ▪ Heart rate >125/min ▪ Respiratory rate >30/min ▪ Use of accessory neck muscles	SpO_2 <92% plus any of: ▪ PEF <33% best or predicted ▪ Silent chest ▪ Poor respiratory effort ▪ Altered consciousness ▪ Cyanosis
	Oxygen via face mask/nasal prongs to achieve SpO_2 94-98%	
▪ β_2 agonist 2-10 puffs via spacer ▪ Increase β_2 agonist dose by 2 puffs every 2 minutes up to 10 puffs according to response ▪ Oral prednisolone 30-40 mg	▪ β_2 agonist 10 puffs via spacer or nebulised salbutamol 2.5-5 mg or terbutaline 5-10 mg ▪ Oral prednisolone 30-40 mg or IV hydrocortisone 4 mg/kg if vomiting ▪ **If poor response** nebulised ipratropium bromide 0.25 mg ▪ Repeat β2 agonist and ipratropium up to every 20-30 minutes according to response	▪ Nebulised β_2 agonist: salbutamol 5 mg or terbutaline 10 mg **plus** ipratropium bromide 0.25 mg nebulised ▪ Oral prednisolone 30-40mg or IV Hydrocortisone 4mg/kg if vomiting **Discuss with senior clinician, PICU team or paediatrician** ▪ Repeat bronchodilators every 20-30 minutes
Reassess within 1 hour		

DISCHARGE PLAN
- Continue β_2 agonist 4 hourly as necessary
- Consider prednisolone 30-40 mg daily for up to 3 days
- Advise to contact GP if not controlled on above treatment
- Provide a written asthma action plan
- Review regular treatment
- Check inhaler technique
- Arrange GP follow up

Arrange immediate transfer to PICU/HDU if poor response to treatment

Admit all cases if features of severe exacerbation persist after initial treatment

Annex 7

Management of acute asthma in children in hospital

Age 2-5 years

ASSESS ASTHMA SEVERITY

Moderate asthma
- SpO_2 ≥92%
- No clinical features of severe asthma

NB: If a patient has signs and symptoms across categories, always treat according to their most severe features

Severe asthma
- SpO_2 <92%
- Too breathless to talk or eat
- Heart rate >140/min
- Respiratory rate >40/min
- Use of accessory neck muscles

Life threatening asthma

SpO_2 <92% plus any of:
- Silent chest
- Poor respiratory effort
- Agitation
- Altered consciousness
- Cyanosis

Oxygen via face mask/nasal prongs to achieve SpO_2 94-98%

- β_2 agonist 2-10 puffs via spacer ± facemask [given one at a time single puffs, tidal breathing and inhaled separately]
- Increase β_2 agonist dose by 2 puffs every 2 minutes up to 10 puffs according to response
- Consider soluble oral prednisolone 20 mg

Reassess within 1 hour

- β_2 agonist 10 puffs via spacer ± facemask or nebulised salbutamol 2.5 mg or terbutaline 5 mg
- Soluble prednisolone 20 mg or IV hydrocortisone 4 mg/kg
- Repeat β_2 agonist up to every 20-30 minutes according to response
- **If poor response** add 0.25 mg nebulised ipratropium bromide

- Nebulised β_2 agonist: salbutamol 2.5 mg or terbutaline 5 mg **plus** ipratropium bromide 0.25 mg nebulised
- Oral prednisolone 20mg or IV hydrocortisone 4mg/kg if vomiting

Discuss with senior clinician, PICU team or paediatrician

- Repeat bronchodilators every 20-30 minutes

ASSESS RESPONSE TO TREATMENT
Record respiratory rate, heart rate and oxygen saturation every 1-4 hours

RESPONDING
- Continue bronchodilators 1-4 hours prn
- Discharge when stable on 4 hourly treatment
- Continue oral prednisolone for up to 3 days

At discharge
- Ensure stable on 4 hourly inhaled treatment
- Review the need for regular treatment and the use of inhaled steroids
- Review inhaler technique
- Provide a written asthma action plan for treating future attacks
- Arrange follow up according to local policy

NOT RESPONDING
- **Arrange HDU/PICU transfer**

Consider:
- **Chest X-ray and blood gases**
- **IV salbutamol** 15 mcg/kg bolus over 10 minutes **followed** by continuous infusion 1-5 mcg/kg/min (dilute to 200 mcg/ml)
- **IV aminophylline** 5 mg/kg loading dose over 20 minutes (omit in those receiving oral theophyllines) **followed by** continuous infusion 1 mg/kg/hour

Age >5 years

ASSESS ASTHMA SEVERITY

Moderate asthma
- SpO_2 ≥92%
- PEF >50% best or predicted
- No clinical features of severe asthma

NB: If a patient has signs and symptoms across categories, always treat according to their most severe features

Severe asthma
- SpO_2 <92%
- PEF 33-50% best or predicted
- Heart rate >125/min
- Respiratory rate >30/min
- Use of accessory neck muscles

Life threatening asthma

SpO_2 <92% plus any of:
- PEF <33% best or predicted
- Silent chest
- Poor respiratory effort
- Altered consciousness
- Cyanosis

Oxygen via face mask/nasal prongs to achieve SpO_2 94-98%

- β_2 agonist 2-10 puffs via spacer
- Increase β_2 agonist dose by 2 puffs every 2 minutes up to 10 puffs according to response
- Oral prednisolone 30-40 mg

Reassess within 1 hour

- β_2 agonist 10 puffs via spacer or nebulised salbutamol 2.5-5 mg or terbutaline 5-10 mg
- Oral prednisolone 30-40 mg or IV hydrocortisone 4 mg/kg if vomiting
- **If poor response** nebulised ipratropium bromide 0.25 mg
- Repeat β2 agonist and ipratropium up to every 20-30 minutes according to response

- Nebulised β_2 agonist: salbutamol 5 mg or terbutaline 10 mg **plus** ipratropium bromide 0.25 mg nebulised
- Oral prednisolone 30-40mg or IV hydrocortisone 4mg/kg if vomiting

Discuss with senior clinician, PICU team or paediatrician

- Repeat bronchodilators every 20-30 minutes

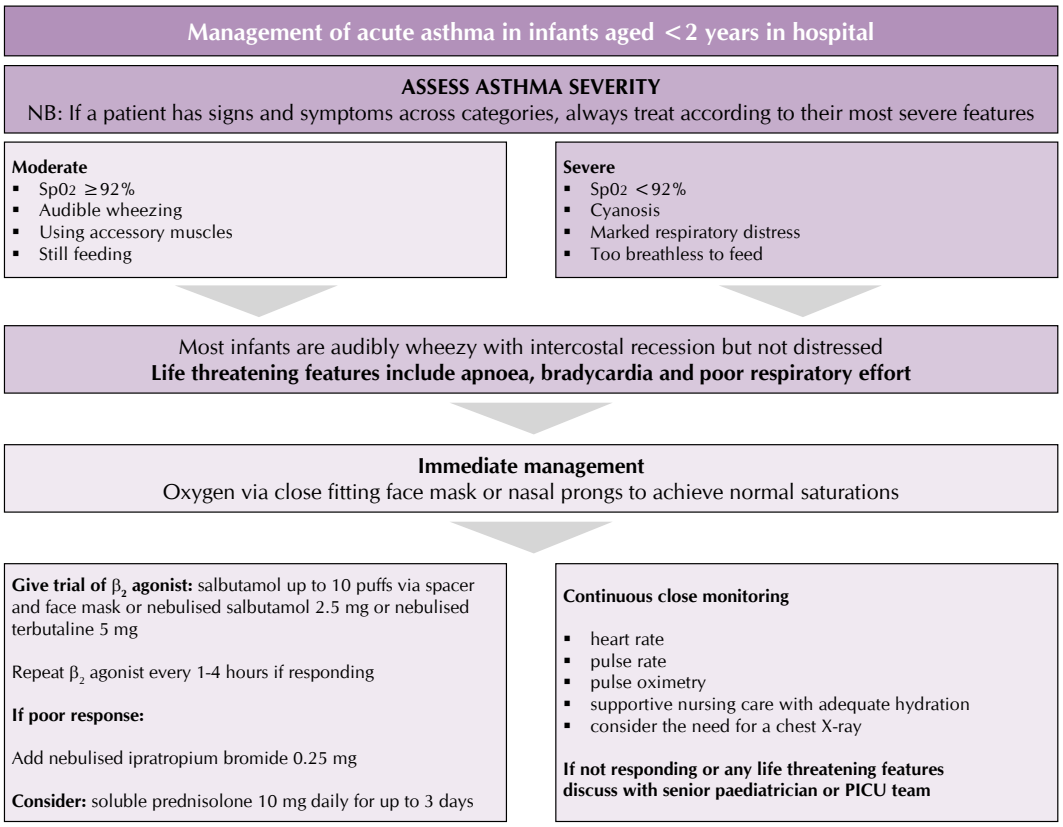
ASSESS RESPONSE TO TREATMENT
Record respiratory rate, heart rate, oxygen saturation and PEF/FEV every 1-4 hours

RESPONDING
- Continue bronchodilators 1-4 hours prn
- Discharge when stable on 4 hourly treatment
- Continue oral prednisolone 30-40 mg for up to 3 days

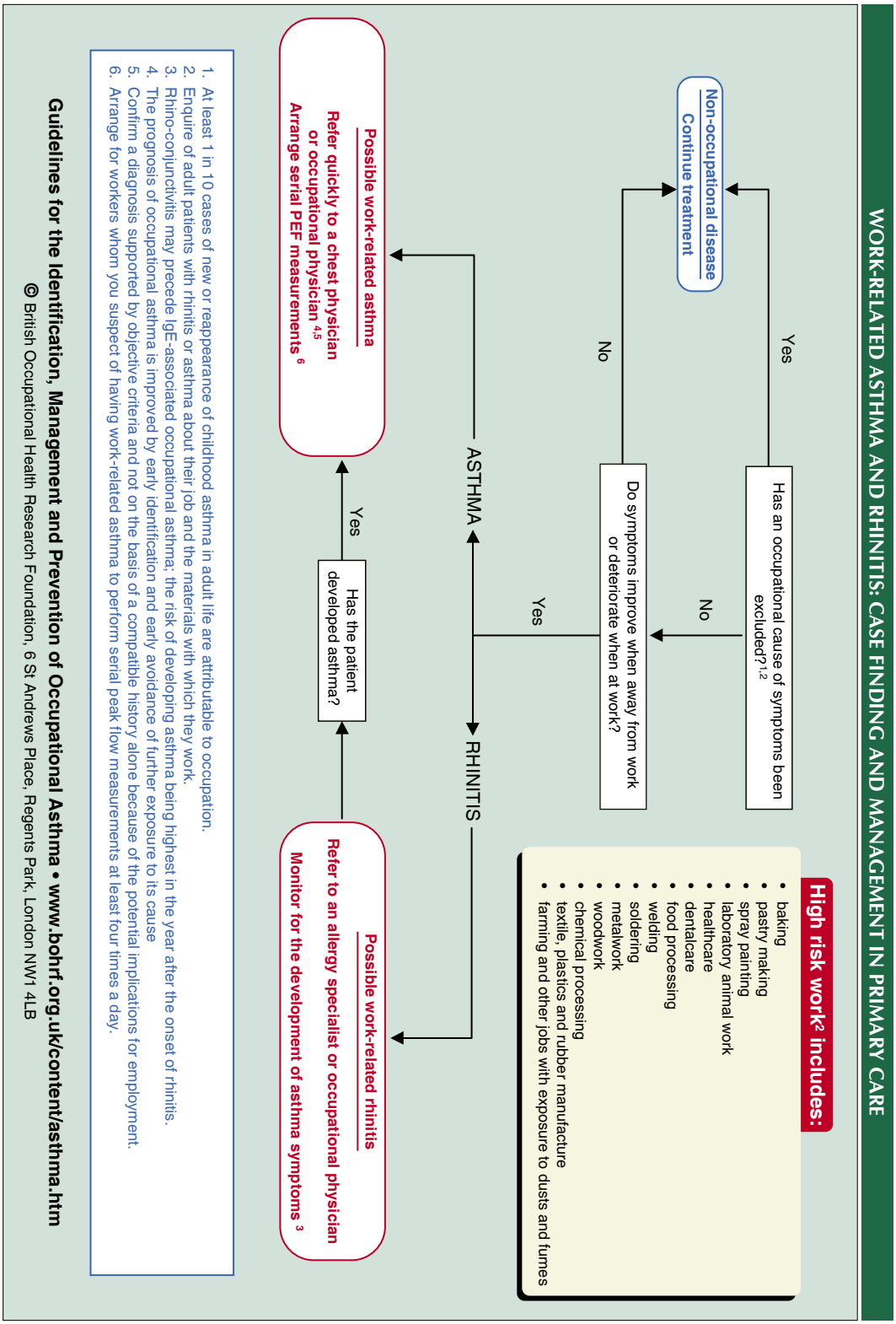
At discharge
- Ensure stable on 4 hourly inhaled treatment
- Review the need for regular treatment and the use of inhaled steroids
- Review inhaler technique
- Provide a written asthma action plan for treating future attacks
- Arrange follow up according to local policy

NOT RESPONDING
- **Continue 20-30 minute nebulisers and arrange HDU/PICU transfer**
- Consider: **Chest X-ray and blood gases**
- **Consider risks and benefits of:**
- **Bolus IV salbutamol** 15 mcg/kg if not already given
- Continuous **IV salbutamol infusion** 1-5 mcg/kg/min (200 mcg/ml solution)
- **IV aminophylline** 5 mg/kg loading dose over 20 minutes (omit in those receiving oral theophyllines) **followed by** continuous infusion 1mg/kg/hour
- **Bolus IV infusion of magnesium sulphate** 40 mg/kg (max 2 g) over 20 minutes

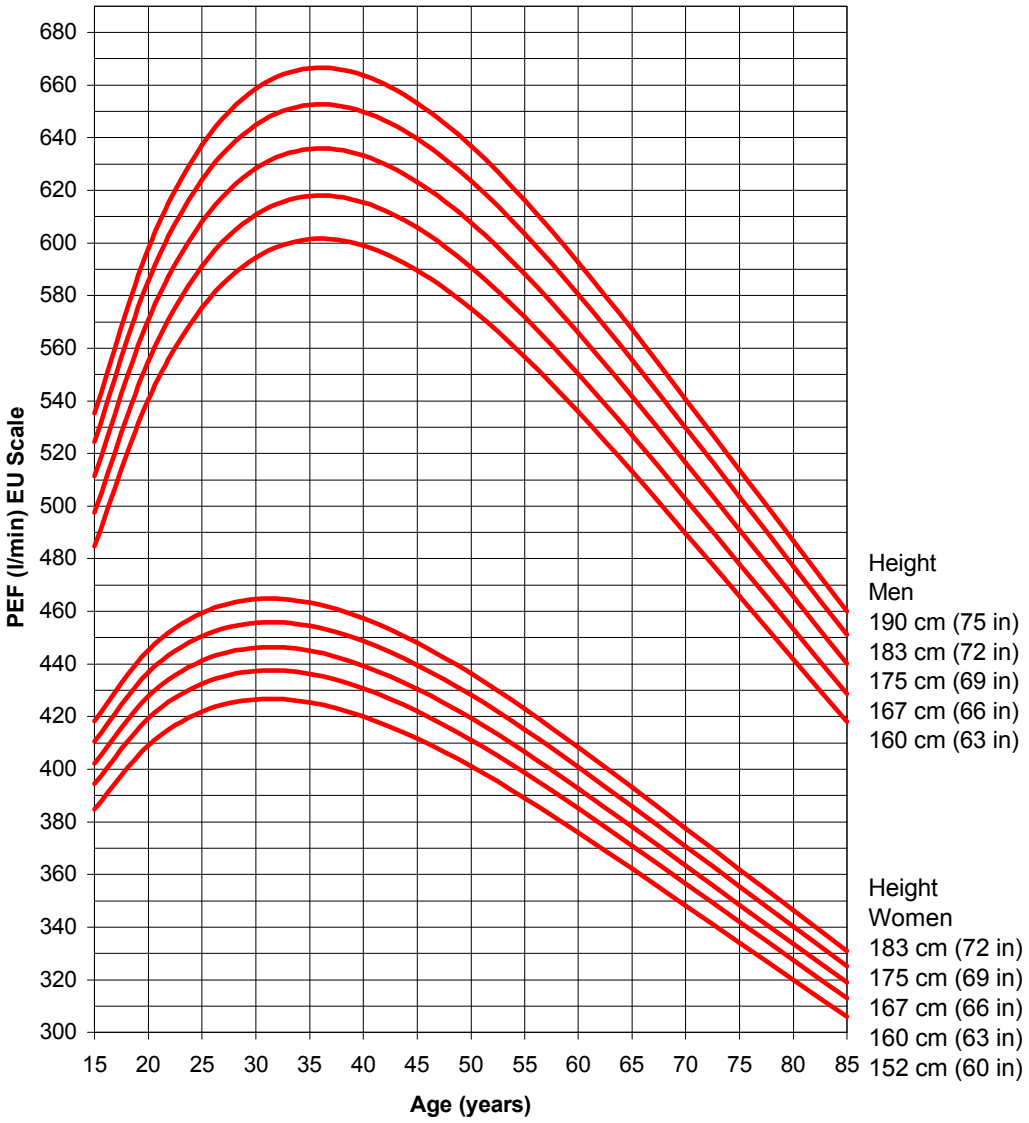
Annex 8


Management of acute asthma in infants aged <2 years in hospital
ASSESS ASTHMA SEVERITY
NB: If a patient has signs and symptoms across categories, always treat according to their most severe features
Moderate
Sp02 ≥92%
Audible wheezing
Using accessory muscles
Still feeding
Severe
Sp02 <92%
Cyanosis
Marked respiratory distress
Too breathless to feed
Most infants are audibly wheezy with intercostal recession but not distressed
Life threatening features include apnoea, bradycardia and poor respiratory effort
Immediate management
Oxygen via close fitting face mask or nasal prongs to achieve normal saturations
Give trial of β2 agonist: salbutamol up to 10 puffs via spacer and face mask or nebulised salbutamol 2.5 mg or nebulised terbutaline 5 mg
Repeat β2 agonist every 1-4 hours if responding
If poor response:
Add nebulised ipratropium bromide 0.25 mg
Consider: soluble prednisolone 10 mg daily for up to 3 days
Continuous close monitoring
heart rate
pulse rate
pulse oximetry
supportive nursing care with adequate hydration
consider the need for a chest X-ray
If not responding or any life threatening features discuss with senior paediatrician or PICU team

Annex 9


WORK-RELATED ASTHMA AND RHINITIS: CASE FINDING AND MANAGEMENT IN PRIMARY CARE
Has an occupational cause of symptoms been excluded?[1,2]
Yes
No
Non-occupational disease
Continue treatment
Do symptoms improve when away from work or deteriorate when at work?
No
Yes
ASTHMA
RHINITIS
Has the patient developed asthma?
Yes
Possible work-related asthma
Refer quickly to a chest physician or occupational physician[4,5]
Arrange serial PEF measurements[6]
Possible work-related rhinitis
Refer to an allergy specialist or occupational physician
Monitor for the development of asthma symptoms[3]
High risk work[2] includes:
baking
pastry making
spray painting
laboratory animal work
healthcare
dentalcare
food processing
welding
soldering
metalwork
woodwork
chemical processing
textile, plastics and rubber manufacture
farming and other jobs with exposure to dusts and fumes
1. At least 1 in 10 cases of new or reappearance of childhood asthma in adult life are attributable to occupation.
2. Enquire of adult patients with rhinitis or asthma about their job and the materials with which they work.
3. Rhino-conjunctivitis may precede IgE-associated occupational asthma; the risk of developing asthma being highest in the year after the onset of rhinitis.
4. The prognosis of occupational asthma is improved by early identification and early avoidance of further exposure to its cause
5. Confirm a diagnosis supported by objective criteria and not on the basis of a compatible history alone because of the potential implications for employment.
6. Arrange for workers whom you suspect of having work-related asthma to perform serial peak flow measurements at least four times a day.
Guidelines for the Identification, Management and Prevention of Occupational Asthma • www.bohrf.org.uk/content/asthma.htm
© British Occupational Health Research Foundation, 6 St Andrews Place, Regents Park, London NW1 4LB

Annex 10

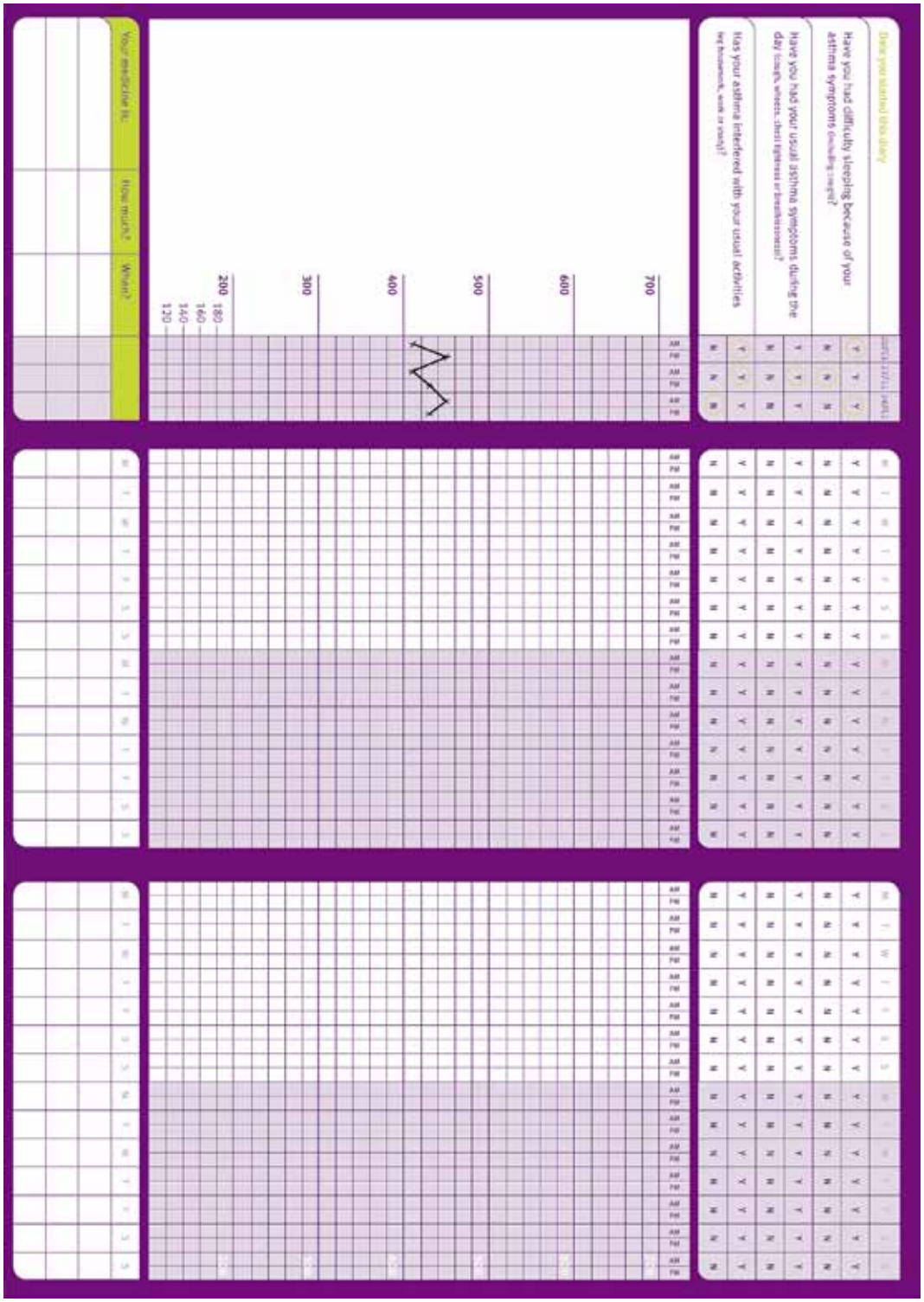


Adapted by Clement Clarke for use with EN13826 / EU scale peak flow meters
from Nunn AJ Gregg I, Br Med J 1989:298;1068-70

Annex 11


About your personal asthma action plan
This plan is intended to be used by people with asthma aged 12 and above.
Your doctor or nurse will fill in this plan with you and explain the different medicines that you should take to control your asthma. It shows you how to recognise when your asthma is getting worse and what you can do about it.
It is reassuring to know that by taking steps early, severe asthma attacks can usually be prevented.
Updating your personal asthma action plan
Because your asthma symptoms can change from day to day, your doctor or nurse may need to change your plan. You should have your asthma reviewed at least once a year.
If your medicine has been changed or increased, visit your doctor or nurse after one month to review your asthma.
Do not stop taking your asthma medicines without talking to your doctor or nurse first.
What to do in an asthma attack
An emergency is when any of the following happen:
1 Your reliever (blue) inhaler does not help
2 Your symptoms get worse (coughing, breathless, wheezy, tight chest)
3 You are too breathless to speak
What you must do during an attack:
1 Take your reliever (blue) inhaler
2 Sit up and loosen tight clothing
3 If no immediate improvement, during an attack, continue to take two puff of reliever inhaler every minute for five minutes or until symptoms improve
4 If your symptoms do not improve in five minutes – or if you are in doubt – call 999 or a doctor urgently
Asthma UK Adviceline
Ask an asthma nurse specialist
08457 01 02 03
asthma.org.uk/adviceline
Asthma UK website
Read the latest independent advice and news on asthma
asthma.org.uk
Asthma UK membership
Become a member of Asthma UK and receive Asthma Magazine four times a year
020 7704 5888
membership@asthma.org.uk
Asthma UK publications
Request booklets, factsheets and other materials with independent, specialist information on every aspect of asthma.
020 7704 5888
info@asthma.org.uk
Asthma UK, Providence House, Providence Place, London N1 0NT
T 020 7226 2260 F 020 7704 0740
© 2004 Asthma UK Registered charity number 802734
Asthma UK Adviceline
Ask an asthma nurse specialist
08457 01 02 03
asthma.org.uk/adviceline
Asthma UK website
Read the latest independent advice and news on asthma
asthma.org.uk
Asthma UK publications
Request a personal asthma action plan and other materials offering independent, specialist advice on every aspect of asthma
020 7704 5888
info@asthma.org.uk
Asthma UK membership
Become a member of Asthma UK and receive Asthma Magazine four times a year
020 7704 5888
membership@asthma.org.uk
Asthma UK, Providence House, Providence Place, London N1 0NT
T 020 7226 2260 F 020 7704 0740
Personal asthma action plan
Be in control
Name
Name of next of kin
Relationship to you
Best of kin contact number
Doctor or nurse contact number
Date plan updated
Drug allergies
Notes
What you can do
Make sure you are taking your medicines as discussed with your doctor or nurse – this information should be written in this card.
Ask your doctor or nurse for a personal asthma action plan. This will help you to know what to do if your symptoms get worse or do not improve.
Asthma medicine card
Name
Doctor or nurse contact number
Knowing what asthma medicines to take and when to take them is a vital first step towards keeping your asthma symptoms to an absolute minimum.
Be in control

Annex 11 (contd)



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