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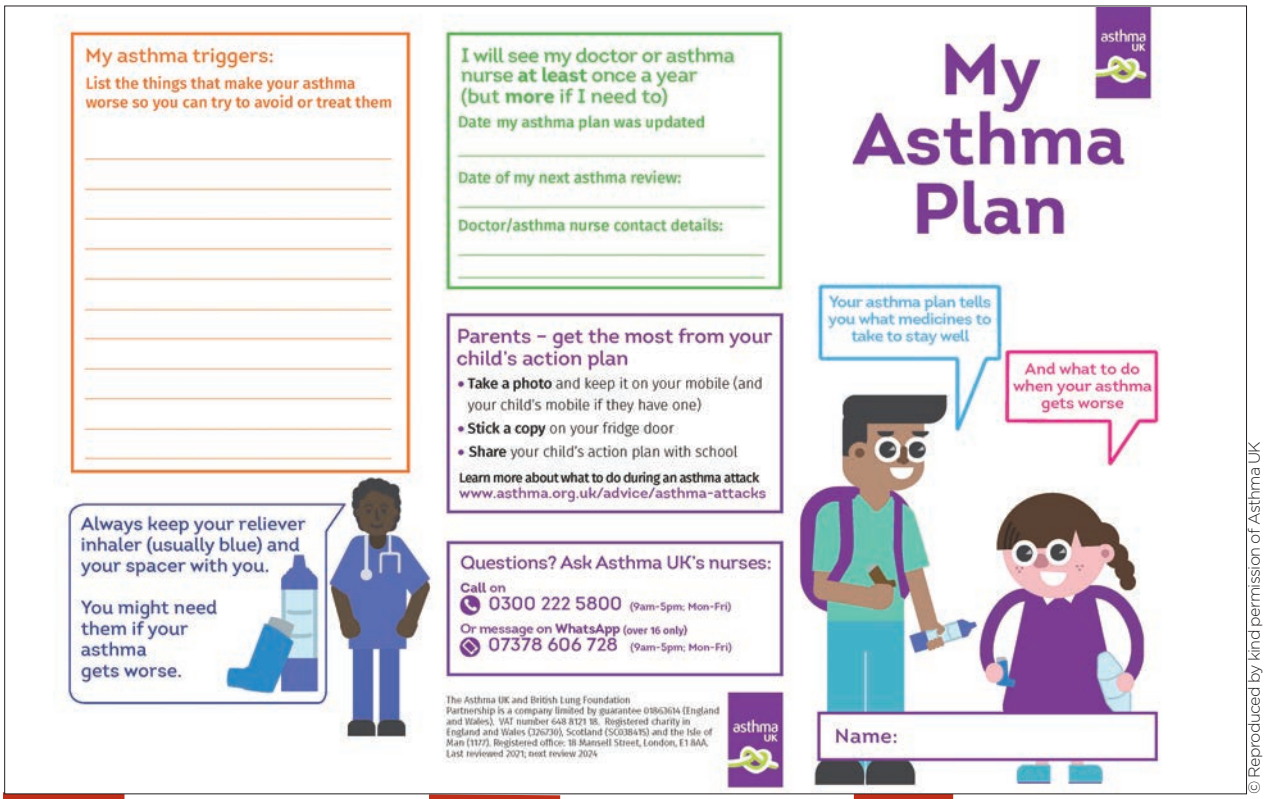


FIGURE 1
Child asthma action plan (page 2 of two pages) Asthma UK. The template can be downloaded free from the Asthma UK website: www.asthma.org.uk

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What are the risk factors for an acute attack?

ASTHMA ATTACKS ARE ONE OF THE MOST COMMON REASONS FOR EMERGENCY PRIMARY CARE or hospital visits in children.[1,2]

Asthma affects 1.1 million children in the UK, and up to 50% experience asthma exacerbations each year.[3] Most of these cases are managed in primary care. However, around 25,000 children are admitted to hospital with asthma annually.[4]

Preschool children under the age of five years have the highest rate of acute wheezing episodes of all age groups with asthma, nearly four times higher than those aged five to 17 years.[5]

Wheeze is produced by airflow turbulence heard during expiration. When airway obstruction worsens, wheeze may also be heard in inspiration, but in severe obstruction it may be absent.

Wheezing can occur with a variety of acute childhood respiratory conditions, other than asthma, see table 1, p18. There are many causes of wheeze in preschool children and this age group is particularly challenging to assess. Recurrent episodes of wheezing are especially common in children born prematurely.

A rhinovirus respiratory infection is by far the most common reason for acute wheezing in preschool children. Importantly, wheezing in this age group responding to short-acting beta$_2$-agonists (SABAs) should be considered a form of asthma.

Asthma is characterised by airway inflammation and hyper-responsiveness to a variety of triggers. Acute asthma attacks result from bronchoconstriction and airway oedema and are characterised by wheeze, chest tightness, worsening cough, shortness of breath, and rapid breathing.

When should children be referred?

RISK FACTORS

The greatest risk factor for an asthma attack in children is a previous asthma attack.[6] Two or more emergency department visits or hospitalisations for asthma in the past year and any history of intensive care admission increase the risk of a future attack.[7]

Modifiable risk factors include poor symptom control, suboptimal treatment regimens, over-reliance on SABAs and poor adherence to preventer therapy.[8] Obesity is associated with a slightly increased risk of asthma attacks.[6]

IDENTIFYING TRIGGERS

It is important to identify allergenic or non-allergenic asthma triggers for each child and note them in the child's asthma action plan, see figure 1, above.[9] NICE recommends the use of skin prick tests for aeroallergens or specific IgE tests to identify asthma triggers, after a formal diagnosis has been made.[10] »

How should children be followed up?

Table 1

Other conditions presenting with childhood wheeze

Bronchiolitis: < two years of age, preceding history of coryzal illness, fever. Diffuse crackles and wheeze on auscultation

Pneumonia (viral or bacterial): History of coryza, cough, fever. Crackles on chest auscultation

Tracheomalacia and cystic fibrosis: Previous known history of condition

Anaphylaxis: Urticarial rash, swelling, exposure to a potential allergen. Cardiovascular instability

Foreign body aspiration: Previously well, short history, may have witnessed choking episode. Asymmetrical breath sounds

Heart failure: History of cardiac abnormality. Heart murmur, hepatomegaly

Viral respiratory tract infections, especially rhinovirus type 4, are powerful triggers of asthma and wheeze in susceptible children and these are difficult to avoid.[11] Asthma attacks may be triggered by exposure to indoor allergens such as house dust mites, moulds and pet fur, and outdoor aeroallergens such as pollens. Although dust mites may trigger asthma attacks, elimination of dust mites may not be effective.[12] Pets, including dogs and cats can trigger asthma attacks in sensitised subjects,[13] but avoidance may be a difficult and sensitive matter for families.

Tree and grass pollens can lead to seasonal asthma attacks in sensitised individuals.[14] Limiting outdoor exposure in the spring and summer may be helpful in some cases. Initiating antihistamine treatment a month before the start of the season may also help.[15]

Cigarette and vape smoke are powerful and avoidable triggers of wheezing and asthma. The current National Asthma and COPD Audit Programme (NACAP)[16] recommends that healthcare professionals reviewing patients with acute asthma ask about smoking and cigarette smoke exposure in the home and offer appropriate advice. Helping parents understand the detrimental effects on their child's asthma control is key in encouraging them to give up smoking.[17] Exposure to air pollution can also lead to asthma attacks requiring hospitalisation.[18]

CLINICAL SIGNS OF AN ASTHMA ATTACK

Younger children may have intercostal and subcostal recessions and tracheal tugging. Older children tend to use their sternocleidomastoid muscles. Severe breathlessness, including inability to complete sentences, is a worrying sign of severe asthma. Auscultation of the chest may reveal wheezing or decreased air entry or a silent chest depending on the severity of the attack. Vital signs often reveal tachypnoea, tachycardia and oxygen saturation < 94% on pulse oximetry in severe attacks.

Attempting a peak expiratory flow (PEF) measurement can be very useful in children aged five years and over when the child presents with an exacerbation. It helps grade the severity of the attack and supports making a correct diagnosis especially when performed before and after salbutamol. The PEF measurement expressed as a percentage of the child's previous best value is most useful.

MANAGEMENT

Asthma attacks are classified as mild, moderate, severe or life-threatening depending on the clinical features. The treatment of acute asthma is detailed in the BTS/SIGN 2019 guidelines[19] and depends on the severity of the asthma attack (see figure 2, p19).

Oxygen therapy

Children with an oxygen saturation < 94% should be given high-flow oxygen via a tight-fitting face mask or nasal cannula to achieve saturation levels of 94-98%.[19]

If GPs do not have oxygen or the appropriate mask/cannula available, for example during out of hours, they should call an emergency ambulance straightaway. Even if arterial oxygen saturation improves after a nebuliser, the child needs to be monitored, which is best done in hospital rather than in an out-of-hours emergency GP setting.

Bronchodilators

Inhaled SABAs such as salbutamol are the first-line treatment for acute asthma in children. A metered dose inhaler + spacer is the preferred option in children with mild to moderate asthma,[20] but nebulisation may be used instead. It is important to remember that 10 puffs of salbutamol are the equivalent of a nebuliser dose. Salbutamol dosing should be individualised to the patient according to the severity of the asthma attack, see box 1, below.

For patients experiencing a mild attack, 200-400 µg (2-4 puffs) may be sufficient and can be increased to 10 puffs if needed. The child should be reassessed after 30 minutes, with the potential to repeat the treatment.

In a child with a severe asthma attack, intensive salbutamol nebulisation, every 20 minutes within the first hour, is usually effective at improving the child's respiratory distress. In case of hypoxia, oxygen-driven nebulisation is recommended, while awaiting ambulance transfer to hospital.

The anticholinergic ipratropium bromide produces a slower bronchodilator response than a SABA, but the combination of the two produces a synergistic effect. Ipratropium bromide should be given early to treat children with a poor response to a SABA.[21] It can be administered up to every 20 minutes within the first hour usually as a combination nebulisation with a SABA. Although this treatment is useful to ameliorate the attack the child is still likely to need transfer to hospital via ambulance.

Corticosteroids

Early administration of systemic corticosteroids, either as prednisolone or dexamethasone, is advised for school-age children with a moderate or severe asthma attack.

Repeated courses of systemic corticosteroids are usually a sign that the asthma is poorly managed and this needs to be addressed once the child has recovered from the asthma attack.

Box 1

Bronchodilator treatment flowchart for acute asthma[19]

Trial of salbutamol

- Via spacer and face mask (one puff of salbutamol at a time, inhaled separately using tidal breathing; according to response, another puff every 60 seconds up to a maximum of 10 puffs) **OR**
- Via nebuliser salbutamol 2.5-5 mg (depending on age), preferably oxygen-driven
- If responding: Repeat salbutamol every 1-4 hours
- If poor response: Add 0.25 mg nebulised ipratropium bromide to each salbutamol nebuliser every 20-30 minutes

Management of acute asthma in children in general practice

Age 2–5 years

ASSESS AND RECORD ASTHMA SEVERITY

Moderate asthma	Acute 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 • Confusion • Cyanosis
	• Oxygen via facemask to maintain SpO_2 94–98% if available	
• β_2 bronchodilator: - via spacer ± facemask* • Consider oral prednisolone 20 mg	• β_2 bronchodilator - via nebuliser (preferably oxygen-driven), salbutamol 2.5 mg - *or*, if nebuliser not available, via spacer* • Oral prednisolone 20 mg	• β_2 bronchodilator with ipratropium: - via nebuliser (preferably oxygen-driven), salbutamol 2.5 mg and ipratropium 0.25 mg every 20 minutes - *or*, if nebuliser and ipratropium not available, β_2 bronchodilator via spacer* • Oral prednisolone 20 mg *or* IV hydrocortisone 50 mg if vomiting
	Assess response to treatment 15 mins after β_2 bronchodilator	
IF POOR RESPONSE ARRANGE ADMISSION	**IF POOR RESPONSE REPEAT β_2 BRONCHODILATOR AND ARRANGE ADMISSION**	**REPEAT β_2 BRONCHODILATOR VIA OXYGEN-DRIVEN NEBULISER WHILST ARRANGING IMMEDIATE HOSPITAL ADMISSION**

GOOD RESPONSE

- Continue β_2 bronchodilator via spacer or nebuliser, as needed but not exceeding 4 hourly
- **If symptoms are not controlled repeat β_2 bronchodilator and refer to hospital**
- Continue prednisolone until recovery (minimum 3-5 days)
- Arrange follow-up clinic visit within 48 hours
- Consider referral to secondary care asthma clinic if 2nd attack within 12 months.

POOR RESPONSE

- Stay with patient until ambulance arrives
- Send written assessment and referral details
- Repeat β_2 bronchodilator 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 AND RECORD ASTHMA SEVERITY

Moderate asthma	Acute severe asthma	Life-threatening asthma
• SpO_2 ≥92% • Able to talk • Heart rate ≤125/min • Respiratory rate ≤30/min • PEF ≥50% best or predicted	• SpO_2 <92% • Too breathless to talk • Heart rate >125/min • Respiratory rate >30/min • Use of accessory neck muscles • PEF 33–50% best or predicted	SpO_2 <92% plus any of: • Silent chest • Poor respiratory effort • Agitation • Confusion • Cyanosis • PEF <33% best or predicted
	• Oxygen via facemask to maintain SpO_2 94–98% if available	
• β_2 bronchodilator: - via spacer* • Consider oral prednisolone 30–40 mg	• β_2 bronchodilator - via nebuliser (preferably oxygen-driven), salbutamol 5 mg - *or*, if nebuliser not available, via spacer* • Oral prednisolone 30–40 mg	• β_2 bronchodilator with ipratropium: - via nebuliser (preferably oxygen-driven), salbutamol 5 mg and ipratropium 0.25 mg every 20 minutes - *or*, if nebuliser and ipratropium not available, β_2 bronchodilator via spacer* • Oral prednisolone 30–40 mg *or* IV hydrocortisone 100 mg if vomiting
	Assess response to treatment 15 mins after β_2 bronchodilator	
IF POOR RESPONSE ARRANGE ADMISSION	**IF POOR RESPONSE REPEAT β_2 BRONCHODILATOR AND ARRANGE ADMISSION**	**REPEAT β_2 BRONCHODILATOR VIA OXYGEN-DRIVEN NEBULISER WHILST ARRANGING IMMEDIATE HOSPITAL ADMISSION**

GOOD RESPONSE

- Continue β_2 bronchodilator via spacer or nebuliser, as needed but not exceeding 4 hourly
- **If symptoms are not controlled repeat β_2 bronchodilator and refer to hospital**
- Continue prednisolone until recovery (minimum 3-5 days)
- Arrange follow-up clinic visit within 48 hours
- Consider referral to secondary care asthma clinic if 2nd attack within 12 months.

POOR RESPONSE

- Stay with patient until ambulance arrives
- Send written assessment and referral details
- Repeat β_2 bronchodilator 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

*** β_2 bronchodilator via spacer given one puff at a time, inhaled separately using tidal breathing; according to response, give another puff every 60 seconds up to a maximum of 10 puffs**

Reproduced from SIGN 158 British guideline on the management of asthma 2019 www.sign.ac.uk

FIGURE 2
Management of acute asthma in children in general practice[19]

key points

SELECTED BY

Dr Peter Saul
GP with an interest in respiratory medicine, Wrexham, UK

Asthma affects 1.1 million children in the UK, and up to 50% experience asthma exacerbations each year. Preschool children under the age of five years have the highest rate of acute wheezing episodes of all age groups with asthma, nearly four times higher than those aged five to 17 years. Wheezing in preschool children responding to short-acting beta$_2$-agonists (SABAs) should be considered a form of asthma.

Asthma is characterised by airway inflammation and hyper-responsiveness to a variety of triggers. Acute asthma attacks are the result of bronchoconstriction and airway oedema. A previous asthma attack is the most important risk factor for future episodes. Modifiable risk factors include poor symptom control, suboptimal treatment regimens, over-reliance on SABAs and poor adherence to preventer therapy.

Viral respiratory tract infections, especially rhinovirus type 4, are powerful triggers of asthma and wheeze in susceptible children. Other triggers include exposure to indoor allergens such as house dust mites, moulds and pet fur, and outdoor aeroallergens such as pollens. Exposure to cigarette and vape smoke are powerful and avoidable triggers and should be enquired about, with appropriate advice offered to parents. Exposure to air pollution can also lead to asthma attacks requiring hospitalisation.

Attempting a peak expiratory flow measurement can be very useful in children aged five years and over when the child presents with an exacerbation. It helps grade the severity of the attack and supports making a correct diagnosis especially when performed before and after salbutamol.

Inhaled SABAs such as salbutamol are the first-line treatment for acute asthma in children. For patients experiencing a mild attack, 200-400 µg (2-4 puffs) may be sufficient and can be increased to 10 puffs if needed. During a severe attack intensive salbutamol nebulisation, every 20 minutes within the first hour is usually effective. It is important to remember that 10 puffs of salbutamol are the equivalent of a nebuliser dose. Ipratropium bromide produces a slower bronchodilator response than a SABA, but the combination of the two produces a synergistic effect. It should be given early to treat children with a poor response to a SABA. Although the treatment is useful to ameliorate the attack the child is still likely to need transfer to hospital via ambulance. Early systemic corticosteroids, prednisolone or dexamethasone, are advised for school-age children with a moderate or severe asthma attack.

Following an asthma attack all children should receive asthma education as well as an updated personalised asthma action plan. Patients and/or their parents must be able to demonstrate appropriate use of inhalers. A GP review should be carried out within two working days of an asthma attack.

Repeated use of systemic steroids should prompt a referral to a paediatrician with an interest in asthma.

In children under the age of five years, recommendations relating to systemic corticosteroids are more complex. Two large randomised controlled trials have shown limited effectiveness of systemic corticosteroids in this age group.[22,23] There are growing concerns regarding the use of frequent courses of oral steroids in younger children where the benefit remains uncertain. A Danish cohort study, involving 291 children, found a significant association between cumulative inhaled corticosteroid exposure during the first six years of life and high BMI at age six.[24]

Systemic corticosteroids should be avoided in children of preschool age with mild attacks of wheezing.

SAFETY NETTING

Children with a mild attack and those with a moderate attack who show a good response to initial treatment can then be managed at home on a maximum of 6 puffs of salbutamol every 4 hours with a spacer and a salbutamol weaning plan. As described above, some children may require a short course of oral corticosteroids, for example prednisolone for 3-5 days.

Following an asthma attack asthma education is mandatory for all children because this reduces asthma-related readmissions,[25] unscheduled GP reviews and days off school, and improves the child's quality of life.[26] Children and/or their parents must be able to demonstrate appropriate use of inhalers and have an updated personalised asthma action plan.

If symptoms recur or persist, emergency medical advice should be sought.

REFERRAL

Children with a severe attack and those responding poorly to initial treatment should be referred to hospital.

Hospital admission should also be considered in the following situations:[19]

- An attack occurring in late afternoon or at night
- Concerns over the parents' ability to cope at home
- Recent hospital admission or previous severe attack

FOLLOW-UP

The BTS/SIGN guidelines and the NICE quality standards recommend a GP review within two working days of an asthma attack.[19,27]

This follow-up after an asthma attack is crucial because it provides the opportunity to review the background controller medication, ensure that the child has returned to baseline in terms of clinical symptoms and reinforce the key aspects of asthma education in a more controlled setting. It is also a good opportunity to answer any questions that the child and/or parents may have and is a key component of preventing asthma deaths.[28]

The following essential points should be addressed with the child and parents during the post attack asthma review:

- Education about asthma and disease management
- A review of the maintenance anti-inflammatory treatment
- A review and advice on adherence to preventer medication
- Checking and improving the inhaler technique with the use of a spacer, and encouraging self-monitoring with a peak flow meter where appropriate
- Completing an updated personalised written asthma action plan
- Helping the family identify and avoid triggers
- Tackling modifiable factors, including parental smoking

The National Review of Asthma Deaths (NRAD) report *Why asthma still kills* found that in more than 60% of asthma deaths, potentially preventable factors were identified.[28] A key recommendation from the report is for practices 'to adopt a system of establishing the risk profile of a patient and put a treatment plan in place that is appropriate to their risk profile'.

GPs should consider referral to a secondary care asthma clinic if the child has had two attacks or more in the past year. Any child with life-threatening features seen in hospital should also have a secondary care follow-up.

Prevention of future asthma attacks

Optimal treatment of chronic asthma is the most effective way of reducing the risk of future attacks; this involves stepping up to the adequate dose of inhaled corticosteroids and/or other controller medication. Children will require regular asthma reviews to gauge the baseline symptom control and response to medication.

It is important to check inhaler technique at each visit. Good inhaler technique is vital to prevent future asthma attacks. International studies, including studies from the UK, have consistently shown that the majority of asthma patients including children have poor inhaler technique.[29,30] There is excellent guidance on inhaler technique

including helpful video materials on the Asthma UK website to share with families and children (see Useful information box, below).

It is vital to communicate effectively with patients and/or their parents, to enable them to understand the importance of good compliance with therapy. Poor adherence to treatment can be identified through a thorough history and examining prescribing records. Prescribing records may provide an approximation of adherence, although cashing a prescription does not necessarily mean that the medication has been taken appropriately.

More objective ways of monitoring adherence being developed include electronic apps and electronic monitoring devices.[30] Currently, these electronic devices are predominantly used in research settings.

After a proven asthma attack, it is essential for GPs to code the diagnosis as asthma and place children diagnosed with asthma on the practice asthma register to ensure that families are invited for an annual asthma review. A thorough annual asthma review in primary care is vital to identify those children at risk of future asthma attacks.[31]

CONCLUSION

Asthma attacks in children are often preventable. Following up children immediately after an attack provides an opportunity to educate children and their families, review asthma medications, adherence and inhaler technique, and identify and modify risk of future asthma attacks.

Competing interests
Dr Erol Gaillard has undertaken consultancy work for Boehringer Ingelheim with fees paid to the institution (University of Leicester), and received investigator led research grants from Chiesi, Gilead, and Circassia, and undertaken research collaboration with Medimmune.
Dr Manisha Ramphul has no competing interests.

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Useful information

Asthma UK
Advice on inhaler technique
Written advice and videos to help children use their inhalers correctly
www.asthma.org.uk/advice/child/medicines/help

Child asthma action plan
Copies of the template can be downloaded
www.asthma.org.uk/a04a7536/globalassets/health-advice/resources/children/my-asthma-plan-child-mar-21.pdf

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