Highlights of the National Asthma Education and Prevention Program’s Expert Panel Report 3 (EPR-3): Guidelines for the Diagnosis and Management of Asthma–Full Report 2007 are presented in this EPR-3 summary report. The updated guidelines emphasize the importance of asthma control. Asthma control is the degree to which the manifestations of asthma are minimized by therapeutic intervention and the goals of therapy are met. Because asthma is highly variable, the level of control must be monitored on a periodic basis to determine whether therapy should be maintained or adjusted (stepped up if necessary, stepped down if possible). On the other hand, asthma severity is the intrinsic intensity of the disease process, most easily and directly measured in a patient not receiving long-term control therapy. For managing asthma, the recommendation is to assess severity to initiate therapy and assess control to adjust therapy.

Recommendations for managing asthma include an expanded section on childhood asthma with addition of an age group 5 to 11 years old (earlier guidelines combined this group with adults). The guidelines provide new recommendations on patient education in settings beyond the physician’s office, and new advice for controlling environmental factors that can cause asthma symptoms.

The concepts of current impairment (frequency and intensity of symptoms, low lung function, and limitations of daily activities) and future risk (likelihood of exacerbations, progressive loss of lung function, or adverse side effects from medications) support a new approach to assessing and monitoring the patient’s level of asthma control through use of multiple measures. The guidelines stress that some patients can still be at high risk for frequent exacerbations even if they have few day-to-day effects of asthma.

Moreover, EPR-3 confirms the importance of teaching patients skills to self-monitor and manage asthma and to use a written asthma action plan, which should include instructions for daily treatment and ways to recognize and handle worsening asthma. New recommendations encourage expanding educational opportunities to reach patients in a variety of settings, such as pharmacies, schools, community centers, and patients’ homes. A new section addresses the need for clinician education programs to improve communication with patients and to use system-wide approaches to integrate the guidelines into health care practice.

The guidelines describe new evidence for using multiple approaches to limit exposure to allergens and other substances that can worsen asthma; research shows that single steps are rarely sufficient. EPR-3 also expands the section on common conditions that can affect asthma and notes that management of these conditions may help to improve asthma control.

Expert Panel Report 3 continues the use of a stepwise approach to control asthma. When assessing the level of asthma control to determine the need for adjusting therapy, EPR-3 reconfirms the importance of assessing patient adherence to medication, inhaler technique, and environmental control measures before making a step up in therapy. The stepwise approach expands from 4 steps to 6 steps of care. Medications have been repositioned within these 6 steps. Recommendations on medications are updated to reflect the latest evidence on effectiveness and safety. EPR-3 reaffirms that patients with persistent asthma need both long-term control medications to control asthma and prevent exacerbations and quick-relief medication for symptoms, as needed. EPR-3 also reaffirms that inhaled corticosteroids are the most effective long-term control medication across all age groups. New recommendations on treatment options such as leukotriene receptor antagonists and cromolyn for long-term control; long-acting β-agonists as adjunct therapy with inhaled corticosteroids; omalizumab for severe asthma; and albuterol, levalbuterol, and corticosteroids for acute exacerbations are included. (J Allergy Clin Immunol 2007;120:S94-138.)

**Abbreviations used**

- COPD: Chronic obstructive pulmonary disease
- ED: Emergency department
- EIB: Exercise-induced bronchospasm
- EPR: Expert Panel Report
- FDA: US Food and Drug Administration
- FVC: Forced vital capacity
- GERD: Gastroesophageal reflux
- ICS: Inhaled corticosteroid
- LABA: Long-acting β2-agonist
- LTRA: Leukotriene receptor antagonist
- MDI: Metered-dose inhaler
- NAEPP: National Asthma Education and Prevention Program
- NHLBI: National Heart, Lung, and Blood Institute
- OSA: Obstructive sleep apnea
- PEF: Peak expiratory flow
- SABA: Short-acting β2-agonist
- VCD: Vocal cord dysfunction
- VHC: Valved holding chamber

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INTRODUCTION

More than 22 million Americans have asthma, and it is one of the most common chronic diseases of childhood, affecting an estimated 6 million children. The burden of asthma affects the patients, their families, and society in terms of lost work and school, lessened quality of life, and avoidable emergency department (ED) visits, hospitalizations, and deaths. Improved scientific understanding of asthma has led to significant improvements in asthma care, and the National Asthma Education and Prevention Program (NAEPP) has been dedicated to translating these research findings into clinical practice through publication and dissemination of clinical practice guidelines. The first NAEPP guidelines were published in 1991, and updates were made in 1997, 2002, and now with the current report. Important gains have been made in reducing morbidity and mortality rates caused by asthma; however, challenges remain. The NAEPP hopes that the Expert Panel Report 3 (EPR-3): Guidelines for the Diagnosis and Management of Asthma—Full Report 2007 will support the efforts of those who already incorporate best practices and will help enlist even greater numbers of primary care clinicians, asthma specialists, health care systems and providers, and communities to join together in making quality asthma care available to all people who have asthma. The goal, simply stated, is to help people with asthma control their asthma so that they can be active all day and sleep well at night.

EPR-3 Summary Report 2007 is a summary of the key recommendations in EPR-3 Full Report 2007. EPR-3 Summary Report 2007 does not include selected references for these recommendations. Rather, EPR-3 Full Report 2007 is considered the resource document, and it contains references and full discussion of the rationale for the recommendations. Accompanying EPR-3 Full Report 2007 are Evidence Tables on topics selected by the expert panel. Both EPR-3 Full Report 2007 and Evidence Tables are available at http://www.nhlbi.nih.gov/guidelines/asthma/index.htm. Detailed recommendations, the levels of scientific evidence on which they are based, citations from the published scientific literature, discussion of the Expert Panel’s rationale for the recommendations, and description of methods used to develop the report are included in that resource document. Because EPR-3 Full Report 2007 is an update of previous NAEPP guidelines, highlights of major changes in the update are presented here, and Fig 1 presents a summary of recommended key clinical activities.
Highlights of major changes in EPR-3 Full Report 2007

The following are highlights of major changes. Many recommendations were updated or expanded on the basis of new evidence. See EPR-3 Full Report 2007 for key differences at the beginning of each section and for a full discussion.

New focus on monitoring asthma control as the goal for asthma therapy and distinguishing between classifying asthma severity and monitoring asthma control.

- Severity: the intrinsic intensity of the disease process. Assess asthma severity to initiate therapy.
- Control: the degree to which the manifestations of asthma are minimized by therapeutic interventions and the goals of therapy are met. Assess and monitor asthma control to adjust therapy.

New focus on impairment and risk as the 2 key domains of severity and control, and emphasis on the use of multiple measures for assessment. The domains represent different manifestations of asthma, they may not correlate with each other, and they may respond differentially to treatment.

- Impairment: frequency and intensity of symptoms and functional limitations the patient is experiencing currently or has recently experienced.
- Risk: the likelihood of either asthma exacerbations, progressive decline in lung function (or, for children, lung growth), or risk of adverse effects from medication.

Modifications in the stepwise approach to managing asthma long-term.

- Treatment recommendations are presented for 3 age groups (0-4 years of age, 5-11 years of age, and youths ≥12 years of age and adults). The course of the disease may change over time; the relevance of different measures of impairment or risk and the potential short-term and long-term effect of medications may be age-related; and varied levels of scientific evidence are available for these 3 age groups.
- The stepwise approach expands to 6 steps to simplify the actions within each step. Previous guidelines had several progressive actions within different steps; these are now separated into different steps.
- Medications have been repositioned within the 6 steps of care.
  - Inhaled corticosteroids (ICSs) continue as preferred long-term control therapy for all ages.
  - Combination of long-acting β2-agonist (LABA) and ICS is presented as an equally preferred option, with increasing the dose of ICS in step 3 care, in patients 5 years of age or older. This approach balances the established beneficial effects of combination therapy in older children and adults with the increased risk for severe exacerbations, although uncommon, associated with daily use of LABA.
  - Omalizumab is recommended for consideration for youths ≥12 years of age who have allergies or for adults who require step 5 or 6 care (severe asthma). Clinicians who administer omalizumab should be prepared and equipped to identify and treat anaphylaxis that may occur.

New emphasis on multifaceted approaches to patient education and to the control of environmental factors or comorbid conditions that affect asthma.

- Patient education for a partnership is encouraged in expanded settings:
  - Patient education should occur in all points of care: clinic settings (offering separate self-management programs as well as integrating education into every patient visit), EDs and hospitals, pharmacies, schools and other community settings, and patients’ homes.
  - Provider education should encourage clinician and health care system support of the partnership (eg, through interactive continuing medical education, communication skills training, clinical pathways, and information system supports for clinical decision-making).
- Environmental control includes several strategies:
  - Multifaceted approaches to reduce exposures are necessary; single steps alone are generally ineffective.
  - Consideration of subcutaneous immunotherapy for patients who have allergies and require care at steps 2 to 4 (mild or moderate persistent asthma) when there is a clear relationship between symptoms and exposure to an allergen to which the patient is sensitive.
  - Potential benefits to asthma control by treating comorbid conditions that affect asthma.

Modifications to treatment strategies for managing asthma exacerbations. These changes:

- Simplify the classification of severity of exacerbations. For the urgent or emergency care setting: <40 percent predicted FEV1 or peak expiratory flow (PEF) indicates severe exacerbation and the potential benefit of using adjunctive therapies; ≥70 percent predicted FEV1 or PEF is a goal for discharge from the emergency care setting.
- Encourage development of prehospital protocols for emergency medical services to allow administration of albuterol, oxygen, and, with medical oversight, anticholinergics and oral systemic corticosteroids.
- Modify recommendations on medications:
  - Add levalbuterol.
  - Add magnesium sulfate or heliox for severe exacerbations unresponsive to initial treatments.
  - Emphasize use of oral corticosteroids. Doubling the dose of ICS for home management is not effective.
  - Emphasize that anticholinergics are used in emergency care, not hospital care.
  - Add consideration of initiating ICS at discharge.
<table>
<thead>
<tr>
<th>Clinical issue</th>
<th>Key clinical activities</th>
<th>Action steps</th>
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<tbody>
<tr>
<td>Diagnosis</td>
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<tr>
<td>Establish asthma diagnosis</td>
<td>Use medical history and physical examination to determine that symptoms of recurrent episodes of airflow obstruction are present. Use spirometry in all patients ≥ 5 years of age to determine that airflow obstruction is at least partially reversible. Consider alternative causes of airflow obstruction.</td>
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<tr>
<td>Managing asthma long-term</td>
<td>Care of asthma every 4–6 months</td>
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<td>Reduce impairment (prevent chronic symptoms, require infrequent use of SABA, maintain near normal lung function and normal activity levels).</td>
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<td>Reduce risks (prevent exacerbations, minimize need for emergency care or hospitalization, prevent loss of lung function, for children, prevent reduced lung growth, have minimal or no adverse effects of therapy).</td>
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<tr>
<td>Four components of care</td>
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<tr>
<td>Assessment and Monitoring</td>
<td>Assess asthma severity to initiate therapy</td>
<td>Use severity classification chart, assessing both domains of impairment and risk, to determine initial treatment.</td>
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<td></td>
<td>Assess asthma control to monitor and adjust therapy</td>
<td>Use asthma control chart assessing both domains of impairment and risk, to determine whether therapy should be maintained or adjusted (step up if necessary, step down if possible). Use multiple measures of impairment and risk: different measures assess different manifestations of asthma; they may not correlate with each other, and they may respond differently to therapy. Obtain lung function measures by spirometry at least every 1–2 y, more frequently for nonwell-controlled asthma.</td>
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<td>Schedule follow-up care</td>
<td>Asthma is highly variable in time, and periodic monitoring is essential. In general, consider scheduling patients at 2-wk to 6-wk intervals while gaining control, at 1–6 mo intervals, depending on step of care required or duration of control, to monitor if sufficient control is maintained, at 3–6 mo intervals if step down in therapy is anticipated. Assess asthma control, medication technique, written asthma action plan, patient adherence and concerns at every visit.</td>
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<tr>
<td>Education</td>
<td>Provide self-management education</td>
<td>Teach and reinforce: Self-monitoring to assess level of asthma control and signs of worsening asthma (other symptom or peak flow monitoring shows similar benefit for most patients). Peak flow monitoring may be particularly helpful for patients who have difficulty perceiving symptoms, a history of severe exacerbations, or moderate or severe asthma. Using written asthma action plan (review differences between long-term control and quick-relief medication). Taking medication correctly (inhaler technique and use of devices). Avoiding environmental factors that worsen asthma. Talk to education to therapy level of patient. Appreciate the potential role of a patient’s cultural beliefs and practices in asthma management.</td>
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<td></td>
<td>Develop a written asthma action plan in partnership with patient (integrate education into all points of care where health professionals interact with patients)</td>
<td>Agree on treatment goals and address patient concerns. Provide instructions for (1) daily management (long-term control medication, if appropriate, and environmental control measures) and (2) managing worsening asthma (how to adjust medication, and know when to seek medical care). Involve all members of the health care team in providing/monitoring education, including physicians, nurses, pharmacists, respiratory therapists, and asthma educators. Encourage education at all points of care (clinics offering separate self-management education programs as well as incorporating education into every patient visit), EOs and hospitals, pharmacies, schools and other community settings, and patients’ homes. Use a variety of educational strategies and methods.</td>
</tr>
<tr>
<td>Control environmental factors and comorbid conditions</td>
<td>Recommended measures to control exposures to allergens and pollutants or irritants that make asthma worse</td>
<td>Determine exposure, history of symptoms in presence of exposures, and sensitivities in patients who have persistent asthma, use skin or in vivo testing to assess sensitivity to perennial indoor allergens. Avoid patients on ways to reduce exposure to those allergens and pollutants or irritants to which the patient is sensitive. Multifaceted approaches are beneficial, single steps alone are generally ineffective. Advise all patients and pregnant women to avoid exposure to tobacco smoke. Consider allergen immunotherapy, by specifically trained personnel, for patients who have persistent asthma and when there is clear evidence of a relationship between symptoms and exposure to an allergen to which the patient is sensitive. Consider especially allergic bronchopulmonary aspergillosis, GERD, obesity, OSA, Thornton and sinusitis, and stress or depression. Recognition and treatment of these conditions may improve asthma control. Consider eradication influenza vaccine for all patients older than 6 mo.</td>
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<tr>
<td>Treat comorbid conditions</td>
<td>Select medication and delivery devices to meet patient’s needs and circumstances</td>
<td>Use stepwise approach to identify appropriate treatment options. IGCS are the most effective long-term control therapy. When choosing among treatment options, consider domain of relevance to the patient (impairment, risk, or both), patient’s history of response to the medication, and patient’s willingness and ability to use the medication.</td>
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<tr>
<td>Medications</td>
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<tr>
<td>Clinical need</td>
<td>Key clinical activities</td>
<td>Action steps</td>
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<tr>
<td>Stepwise approach</td>
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<tr>
<td>General principles for all age groups</td>
<td>Incorporate 4 components of care</td>
<td>Include medications, patient education, environmental control measures, and management of comorbidities at each step. Monitor asthma control regularly (see assessment and monitoring). For patients not taking long-term control therapy: select treatment step on the basis of severity (see figures on stepwise approach for different age groups). Patients who have persistent asthma require daily long-term control medication. Once therapy is initiated, monitor the level of asthma control and adjust therapy accordingly: step up if necessary and step down if possible to identify the minimum amount of medication required to maintain asthma control. Refer to an asthma specialist for consultation or management if there are difficulties achieving or maintaining control; step 4 care or higher is required (step 3 care or higher for children 6–y of age). Immunotherapy or omalizumab is considered; or additional testing is indicated; or if the patient required 3 fronts of oral systemic corticosteroids in the past year or as hospitalization.</td>
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<tr>
<td>Age 6–y</td>
<td>Consider daily long-term control therapy</td>
<td>Young children may be at high risk for severe exacerbations, yet have low levels of impairment between exacerbations. Initiate daily long-term control therapy for:</td>
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<td>Children who had ≥ 4 episodes of wheezing the past year that lasted ≥ 1d and affected sleep AND who have a positive asthma risk profile, either 1 of the following: parental history of asthma, physician diagnosis of atopic dermatitis, or evidence of sensitization to allergens; OR 2 of the following: sensitization to foods, ≥ 4 percent blood eosinophils, or wheezing apart from colds.</td>
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<td>Consider initiating daily long-term control therapy for:</td>
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<td>Children who consistently require SABA treatment 2x–4x the above. Children who have 2 exacerbations requiring oral systemic corticosteroids within 6 mo. If no clear and positive response occurs within 4–6 wk and the patient/physician’s medication technique strategy, and adherence are satisfactory, stop the treatment and consider alternative therapies or discontinuation. If clear benefit is sustained for at least 3 mo, consider step down to evaluate the continued need for daily therapy. Children this age have high rates of spontaneous remission of symptoms.</td>
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FIG 1. Summary of recommended key clinical activities for the diagnosis and management of asthma.
<table>
<thead>
<tr>
<th>Clinical Issue</th>
<th>Key clinical activities</th>
<th>Action steps</th>
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<tbody>
<tr>
<td><strong>Ages 5-11 y</strong></td>
<td><strong>Involves child in developing a written asthma action plan and reviewing adherence</strong></td>
<td>Address child’s concerns, preferences, and school schedule in selecting treatments. Encourage students to take a copy of written asthma action plan to school/after-school activities.</td>
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<td></td>
<td><strong>Promote physical activity</strong></td>
<td>Treat EIB. Step up daily therapy if the child has poor endurance or symptoms during normal play activities.</td>
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<td></td>
<td><strong>Monitor for disease progression and loss of lung growth</strong></td>
<td>Treatment will not alter underlying progression of the disease, but a step up in therapy may be required to maintain asthma control.</td>
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<tr>
<td><strong>Ages 12 and Older</strong></td>
<td><strong>Involves youths in developing a written asthma action plan and reviewing adherence</strong></td>
<td>Address youth’s concerns, preferences, and school schedule in selecting treatment. Encourage students to take a copy of a written asthma action plan to school/after-school activities.</td>
</tr>
<tr>
<td></td>
<td><strong>Promote physical activity</strong></td>
<td>Treat EIB. Step up daily therapy if the child has poor endurance or symptoms during normal daily activities.</td>
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<td></td>
<td><strong>Assess possible benefit of treatment in older patients</strong></td>
<td>Establish reversibility with a short course of oral systemic corticosteroids.</td>
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<td><strong>Adjust medications to address coexisting medical conditions common among older patients</strong></td>
<td>Consider, for example: calcium and vitamin D supplements for patients who take ICS and have risk factors for osteoporosis; increased sensitivity to side effects of bronchodilators with increasing age; increased drug interactions with theophylline, medications for arthritis (nonsteroidal anti-inflammatory drugs), hypertension, or glaucoma (β-blockers) may exacerbate asthma.</td>
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**Clinical Issue** | **Key clinical activities** | **Action steps** |
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<td><strong>Special situations</strong></td>
<td><strong>EIB</strong></td>
<td><strong>Prevent EIB</strong></td>
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<td></td>
<td><strong>Pregnancy</strong></td>
<td><strong>Maintain asthma control through pregnancy</strong></td>
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<td><strong>Surgery</strong></td>
<td><strong>Reduce risks for complications during and after surgery</strong></td>
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</tbody>
</table>

**Managing exacerbations** | **Home management** | Incorporate 4 components of care |
| | Develop a written asthma action plan | Include assessment and monitoring, patient education, environmental control, and medications. |
| | Instruct patients/have to: Recognize early signs, symptoms, PEFR measures that indicate worsening asthma. | |
| | Adjust medications (increase SABA and, in some cases, add oral systemic corticosteroids) and remove or withdraw from environmental factors contributing to the exacerbation. | |
| | Monitor response and seek medical care if there is serious deterioration or lack of response to treatment. | |

**Clinical Issue** | **Key clinical activities** | **Action steps** |
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<tbody>
<tr>
<td><strong>Management in the urgent or emergency care setting</strong></td>
<td><strong>Assess severity</strong></td>
<td>Treatment strategies include:</td>
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<tr>
<td></td>
<td><strong>Treat to relieve hypoxemia and airflow obstruction; reduce airway inflammation</strong></td>
<td>• Assessing initial severity by lung function measures (for ages 5 y) and symptoms and functional assessment.</td>
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<td></td>
<td><strong>Monitor response</strong></td>
<td>• Supplemental oxygen.</td>
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<td><strong>Discharge with medication and patient education</strong></td>
<td>• Repeatable or continuous SABA.</td>
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<td>• Oral systemic corticosteroids.</td>
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<td></td>
<td>• Monitoring response with serial assessment of lung function measures, pulse oximetry, and symptoms.</td>
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<td>• Considering adjunctive treatments magnesium sulfate or heparin in severe exacerbations (eg, FEV1 or PEFR &lt;40% predicted) unresponsive to initial treatment.</td>
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<td>• Providing at discharge:</td>
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<td>— Medications: SABA, oral systemic corticosteroids; consider initiating ICS.</td>
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<td>— Referral to follow-up care.</td>
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<td>— An ED asthma discharge plan.</td>
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<td>• Review of inhaler technique and, whenever possible, environmental control measures.</td>
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FIG 1. Continued.
ASTHMA DEFINITION AND IMPLICATIONS FOR TREATMENT

Definition and pathophysiology

Asthma is a complex disorder characterized by variable and recurring symptoms, airflow obstruction, bronchial hyperresponsiveness, and an underlying inflammation. The interaction of these features determines the clinical manifestations and severity of asthma (Fig 2) and the response to treatment. The working definition of asthma is as follows:

**Asthma is a chronic inflammatory disorder of the airways in which many cells and cellular elements play a role:** in particular, mast cells, eosinophils, neutrophils (especially in sudden onset, fatal exacerbations, occupational asthma, and patients who smoke), T lymphocytes, macrophages, and epithelial cells. In susceptible individuals, this inflammation causes recurrent episodes of coughing (particularly at night or early in the morning), wheezing, breathlessness, and chest tightness. These episodes are usually associated with widespread but variable airflow obstruction that is often reversible either spontaneously or with treatment.

Airflow limitation is caused by a variety of changes in the airway, all influenced by airway inflammation:

- **Bronchoconstriction**—bronchial smooth muscle contraction that quickly narrows the airways in response to exposure to a variety of stimuli, including allergens or irritants.
- **Airway hyperresponsiveness**—an exaggerated bronchoconstrictor response to stimuli.
- **Airway edema**—as the disease becomes more persistent and inflammation becomes more progressive, edema, mucus hypersecretion, and formation of inspissated mucus plugs further limit airflow.

Remodeling of airways may occur. Reversibility of airflow limitation may be incomplete in some patients. Persistent changes in airway structure occur, including subbasement fibrosis, mucus hypersecretion, injury to epithelial cells, smooth muscle hypertrophy, and angiogenesis.

Recent studies provide insights on different phenotypes of asthma that exist. Different manifestations of asthma may have specific and varying patterns of inflammation (eg, varying intensity, cellular mediator pattern, and therapeutic response). Further studies will determine whether different treatment approaches benefit the different patterns of inflammation.

Causes of asthma

The development of asthma appears to involve the interplay between host factors (particularly genetics) and environmental exposures that occur at a crucial time in the development of the immune system. A definitive cause of the inflammatory process leading to asthma has not yet been established.

- **Innate immunity.** Numerous factors may affect the balance between T-helper 1-type and T-helper 2-type cytokine responses in early life and increase the likelihood that the immune response will downregulate the T-helper 1 immune response that fights infection and instead will be dominated by T-helper 2 cells, leading to the expression of allergic diseases and asthma. This is known as the hygiene hypothesis, which postulates that certain infections early in life, exposure to other children (eg, presence of older siblings and early enrollment in childcare, which have greater likelihood of exposure to respiratory infection), less frequent use of antibiotics, and country living are associated with a TH1 response and lower incidence of asthma, whereas the absence of these factors is associated with a persistent TH2 response and higher rates of asthma. Interventions to prevent the onset of this process (eg, with probiotics) are under study, but no recommendations can yet be made.

- **Genetics.** Asthma has an inheritable component, but the genetics involved remain complex. As the linkage of genetic factors to different asthma phenotypes becomes clearer, treatment approaches may become directed to specific patient phenotypes and genotypes.

- **Environmental factors.**
  - Two major factors are the most important in the development, persistence, and possibly the severity of asthma: airborne allergens (particularly sensitization and exposure to house dust mite and *Alternaria*) and viral respiratory infections (including respiratory syncytial virus and rhinovirus).
  - Other environmental factors are under study: tobacco smoke (exposure in utero is associated with an increased risk of wheezing, but it is not certain this is linked to subsequent development of asthma), air pollution (ozone and particulate matter), and diet (obesity or low intake of antioxidants and ω-3 fatty acids). The association of these factors with the onset of asthma has not been clearly defined. A number of clinical trials have investigated dietary and environmental manipulations, but these trials have not been sufficiently long-term or conclusive to permit recommendations.
Implications for treatment

Knowledge of the importance of inflammation to the central features of asthma continues to expand and underscores inflammation as a primary target of treatment. Studies indicate that current therapeutic approaches are effective in controlling symptoms, reducing airflow limitation, and preventing exacerbations, but currently available treatments do not appear to prevent the progression of asthma in children. As various phenotypes of asthma are defined and inflammatory and genetic factors become more apparent, new therapeutic approaches may be developed that will allow even greater specificity to tailor treatment to the individual patient’s needs and circumstances.
DIAGNOSIS OF ASTHMA

To establish a diagnosis of asthma, the clinician should determine that:

- Episodic symptoms of airflow obstruction or airway hyperresponsiveness are present.
- Airflow obstruction is at least partially reversible, measured by spirometry. Reversibility is determined by an increase in FEV₁ of ≥200 mL and ≥12% from baseline measure after inhalation of short-acting β₂-agonist (SABA). Some studies indicate that an increase of ≥10% of the predicted FEV₁ after inhalation of a SABA may have higher likelihood of separating patients who have asthma from those who have chronic obstructive pulmonary disease (COPD).
- Alternative diagnoses are excluded. See discussion below.

Recommended methods to establish the diagnosis are the following:

- Detailed medical history. See Fig 3 for questions to include.
- Physical examination may reveal findings that increase the probability of asthma, but the absence of these findings does not rule out asthma, because the disease is variable and signs may be absent between episodes. The examination focuses on the following:
  - The upper respiratory tract (increased nasal secretion, mucosal swelling, and/or nasal polyps)
  - The chest (sounds of wheezing during normal breathing or prolonged phase of forced exhalation, hyperexpansion of the thorax, use of accessory muscles, appearance of hunched shoulders, chest deformity)
- Spirometry can demonstrate obstruction and assess reversibility in patients ≥5 years of age. Patients’ perceptions of airflow obstruction are highly variable. Spirometry is an essential objective measure to establish the diagnosis of asthma, because the medical history and physical examination are not reliable means of excluding other diagnoses or of assessing lung status. Spirometry is generally recommended, rather than measurements by a peak flow meter, because of wide variability in peak flow meters and reference values. Peak flow meters are designed for monitoring, not as diagnostic tools.

A differential diagnosis of asthma should be considered. Recurrent episodes of cough and wheezing most often are caused by asthma in both children and adults; however, other significant causes of airway obstruction leading to wheeze must be considered both in the initial diagnosis and if there is no clear response to initial therapy.

Key symptom indicators for considering a diagnosis of asthma

The presence of multiple key indicators increases the probability of asthma, but spirometry is needed to establish a diagnosis.

- Wheezing—high-pitched whistling sounds when breathing out—especially in children. A lack of wheezing and a normal chest examination do not exclude asthma.
- History of any of the following:
  - Cough (worse particularly at night)
  - Recurrent wheeze
  - Recurrent difficulty in breathing
  - Recurrent chest tightness
- Symptoms occur or worsen in the presence of the following:
  - Exercise
  - Viral infection
  - Inhalant allergens (eg, animals with fur or hair, house-dust mites, mold, pollen)
  - Irritants (tobacco or wood smoke, airborne chemicals)
  - Changes in weather
  - Strong emotional expression (laughing or crying hard)
  - Stress
  - Menstrual cycles
- Symptoms occur or worsen at night, awakening the patient.
Additional pulmonary function studies will help if there are questions about COPD (diffusing capacity), a restrictive defect (measures of lung volumes), or VCD (evaluation of inspiratory flow-volume loops).

Bronchoprovocation with methacholine, histamine, cold air, or exercise challenge may be useful when asthma is suspected and spirometry is normal or near normal. For safety reasons, bronchoprovocation should be performed only by a trained individual. A positive test is diagnostic for airway hyperresponsiveness, which is a characteristic feature of asthma but can also be present in other conditions. Thus, a positive test is consistent with asthma, but a negative test may be more helpful to rule out asthma.

Chest x-ray may be needed to exclude other diagnoses.

Biomarkers of inflammation are currently being evaluated for their usefulness in the diagnosis and assessment of asthma. Biomarkers include total and differential cell count and mediator assays in sputum, blood, urine, and exhaled air.

Common diagnostic challenges include the following:

Cough variant asthma. Cough can be the principal—or only—manifestation of asthma, especially in young children. Monitoring of PEF or bronchoprovocation may be helpful. Diagnosis is confirmed by a positive response to asthma medications.

Vocal cord dysfunction can mimic asthma, but it is a distinct disorder. VCD may coexist with asthma. Asthma medications typically do little, if anything, to relieve VCD symptoms. Variable flattening of the inspiratory flow loop on spirometry is strongly suggestive of VCD. Diagnosis of VCD is from indirect or direct vocal cord visualization during an episode, during which the abnormal adduction can be documented. VCD should be considered in patients with difficult-to-treat, atypical asthma and in elite athletes who have exercise-related breathlessness unresponsive to asthma medication.

Gastroesophageal reflux disease (GERD), obstructive sleep apnea (OSA), and allergic bronchopulmonary aspergillosis may coexist with asthma and complicate diagnosis. See “Comorbid Conditions” for further discussion.

Children ages 0 to 4 years. Diagnosis in infants and young children is challenging and is complicated by the difficulty in obtaining objective measurements of lung function in this age group. Caution is needed to avoid giving young children inappropriate prolonged asthma therapy. However, it is important to avoid underdiagnosing asthma, and thereby missing the opportunity to treat a child, by using such labels as “wheezy bronchitis,” “recurrent pneumonia,” or “reactive airway disease.” The chronic airway inflammatory response and structural changes that are characteristic of asthma can develop in the preschool years, and appropriate asthma treatment will reduce morbidity.

Consider referral to an asthma specialist if signs and symptoms are atypical, if there are problems with a differential diagnosis, or if additional testing is indicated.
MANAGING ASTHMA LONG-TERM

Achieving and maintaining asthma control requires 4 components of care: assessment and monitoring, education for a partnership in care, control of environmental factors and comorbid conditions that affect asthma, and medications. A stepwise approach to asthma management incorporates these 4 components, emphasizing that pharmacologic therapy is initiated on the basis of asthma severity and adjusted (stepped up or down) on the basis of the level of asthma control. Special considerations of therapeutic options within the stepwise approach may be necessary for situations such as EIB, surgery, and pregnancy.

Four components of asthma care

Component 1: assessing and monitoring asthma severity and asthma control

The functions of assessment and monitoring are closely linked to the concepts of severity, control, and responsiveness to treatment:

- **Severity**: the intrinsic intensity of the disease process. Severity is most easily and directly measured in a patient who is not receiving long-term control therapy. Severity can also be measured, once asthma control is achieved, by the step of care (ie, the amount of medication) required to maintain control.

- **Control**: the degree to which the manifestations of asthma are minimized by therapeutic intervention and the goals of therapy are met.

- **Responsiveness**: the ease with which asthma control is achieved by therapy.

Asthma severity and asthma control include the domains of current impairment and future risk.

- **Impairment**: frequency and intensity of symptoms and functional limitations the patient is currently experiencing or has recently experienced.

- **Risk**: the likelihood of either asthma exacerbations, progressive decline in lung function (or, for children, reduced lung growth), or risk of adverse effects from medication.

This distinction emphasizes the multifaceted nature of asthma and the need to consider separately asthma’s current, ongoing effects on the current quality of life and functional capacity, and the future risk of adverse events. The two domains may respond differentially to treatment. For example, evidence demonstrates that some patients can have adequate control of symptoms and minimal day-to-day impairment but still be at significant risk of exacerbations; these patients should be treated accordingly.

The specific measures used to assess severity and control are similar: symptoms, use of SABAs for quick relief of symptoms, limitations to normal activities because of asthma, pulmonary function, and exacerbations. Multiple measures are important because different measures assess different manifestations of the disease and may not correlate with each other.

The concepts of severity and control are used as follows for managing asthma:

- **Assess severity to initiate therapy.** See “Stepwise Approach for Managing Asthma” for figures on classifying asthma severity and initiating therapy in different age groups. During a patient’s initial presentation, if the patient is not currently taking long-term control medication, asthma severity is assessed to guide clinical decisions for initiating the appropriate medication and other therapeutic interventions.

- **Assess control to adjust therapy.** See “Stepwise Approach for Managing Asthma” for figures on assessing asthma control and adjusting therapy in different age groups. Once therapy is initiated, the emphasis for clinical management thereafter is changed to the assessment of asthma control. The level of asthma control will guide decisions either to maintain or to adjust therapy (ie, step up if necessary, step down if possible).

- **For assessing a patient’s overall asthma severity, once the most optimal asthma control is achieved and maintained, or for population-based evaluations or clinical research, asthma severity can be inferred by correlating the level of severity with the lowest level of treatment required to maintain control.**

However, the emphasis for clinical management is to assess asthma severity before initiating therapy and then to assess asthma control for monitoring and adjusting therapy.

For the initial assessment to characterize the patient’s asthma and guide decisions for initiating therapy, use information from the diagnostic evaluation to do the following:

- **Classify asthma severity.**

- **Identify precipitating factors** for episodic symptoms (eg, exposure at home, work, day care, or school to inhalant allergens or irritants).

- **Identify comorbid conditions** that may impede asthma management (eg, sinusitis, rhinitis, GERD, OSA, obesity, stress, or depression).

- **Assess the patient’s knowledge and skills** for self-management.

For periodic monitoring of asthma control to guide decisions for maintaining or adjusting therapy:

- **Instruct patients to monitor their asthma control in an ongoing manner.** All patients should be taught how to recognize inadequate asthma control.

  — Either symptom or peak flow monitoring is appropriate for most patients; evidence suggests the benefits are similar.
Goal of therapy: control of asthma

Reduce impairment
- Prevent chronic and troublesome symptoms (eg, coughing or breathlessness in the daytime, in the night, or after exertion).
- Require infrequent use (≤2 days a week) of inhaled SABA for quick relief of symptoms (not including prevention of exercise-induced bronchospasm [EIB]).
- Maintain (near) normal pulmonary function.
- Maintain normal activity levels (including exercise and other physical activity and attendance at school or work).
- Meet patients’ and families’ expectations of and satisfaction with asthma care.

Reduce risk
- Prevent recurrent exacerbations of asthma and minimize the need for ED visits or hospitalizations.
- Prevent loss of lung function; for children, prevent reduced lung growth.
- Provide optimal pharmacotherapy with minimal or no adverse effects.

Classification of asthma severity when asthma is well controlled

<table>
<thead>
<tr>
<th>Intermittent</th>
<th>Persistent</th>
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<td>Moderate</td>
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<td>Moderate</td>
<td>Severe</td>
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<table>
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<tr>
<th>Lowest level</th>
<th>of treatment required to maintain control</th>
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<td>(See “Stepwise Approach for Managing Asthma” for treatment steps.)</td>
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- Consider daily peak-flow monitoring for patients who have moderate or severe persistent asthma, patients who have a history of severe exacerbations, and patients who poorly perceive airway obstruction or worsening asthma.
- Monitor asthma control periodically in clinical visits, because asthma is highly variable over time and therapy may need to be adjusted (stepped up if necessary, stepped down if possible). The frequency of monitoring is a matter of clinical judgment. In general:
  - Schedule visits at 2-week to 6-week intervals for patients who are just starting therapy or who require a step up in therapy to achieve or regain asthma control.
  - Schedule visits at 1-month to 6-month intervals, after asthma control is achieved, to monitor whether asthma control is maintained. The interval will depend on factors such as the duration of asthma control or the level of treatment required.
  - Consider scheduling visits at 3-month intervals if a step down in therapy is anticipated.
- Assess asthma control, medication technique, the written asthma action plan, adherence, and patient concerns at every patient visit. See Fig 4 for a sample patient self-assessment of overall asthma control and asthma care.
- Use spirometry to obtain objective measures of lung function.
  — Perform spirometry at the following times:
    - At the initial assessment.
    - After treatment is initiated and symptoms and PEF have stabilized.
    - During periods of progressive or prolonged loss of asthma control.
    - At least every 1 to 2 years; more frequently depending on response to therapy.
    - Low FEV1 indicates current obstruction (impairment) and risk for future exacerbations (risk). For children, FEV1/forced vital capacity (FVC) appears to be a more sensitive measure of severity and control in the impairment domain. FEV1 is a useful measure of risk for exacerbations, although it is emphasized that even children who have normal lung function experience exacerbations.
  - Minimally invasive markers (called biomarkers) such as fractionated exhaled nitric oxide and sputum eosinophils may be useful, but biomarkers require further evaluation before they can be recommended as clinical tools for routine management.

Component 2: education for a partnership in care
A partnership between the clinician and the person who has asthma (and the caregiver, for children) is required for effective asthma management. By working together, an appropriate treatment can be selected, and the patient can learn self-management skills necessary to control asthma. Self-management education improves patient outcomes (eg, reduced urgent care visits, hospitalizations, and limitations on activities as well as improved health status, quality of life, and perceived control of asthma) and can be cost-effective. Self-management education is an integral component of effective asthma care and should be treated as such by health care providers as well as health care policies and reimbursements.

Develop an active partnership with the patient and family by doing the following:
- Establish open communications that consider cultural and ethnic factors, as well as language and health care literacy needs, of each patient and family.
- Identify and address patient and family concerns about asthma and asthma treatment.
Develop treatment goals and selecting medications together with the patient and family, allowing full participation in treatment decision-making.

Encourage self-monitoring and self-management by reviewing at each opportunity the patient’s reports of asthma symptoms and response to treatment.

Provide to all patients a written asthma action plan that includes instructions for both daily management (long-term control medication, if appropriate, and environmental control measures) and actions to manage worsening asthma (what signs, symptoms, and PEF measurements [if used] indicate worsening asthma; what medications to take in response; what signs and symptoms indicate the need for immediate medical care). Written asthma action plans are particularly recommended for patients who have moderate or severe persistent asthma (ie, requiring treatment at step 4, 5, or 6), a history of severe exacerbations, or poorly controlled asthma. Figs 5 and 6 provide samples of written asthma action plans.

Integrate asthma self-management education into all aspects of asthma care. Asthma self-management requires repetition and reinforcement. It should do the following:

- Begin at the time of diagnosis and continue through follow-up care. Fig 7 provides a sample of how to incorporate teaching into routine clinic visits.
- Involve all members of the health care team, including physicians, nurses, pharmacists, respiratory therapists, and asthma educators, as well as other health professionals who come in contact with patients with asthma and their families.
- Occur at all points of care where health care professionals interact with patients who have asthma. The
Key educational messages: teach and reinforce at every opportunity

Basic facts about asthma
- The contrast between airways of a person who has and a person who does not have asthma; the role of inflammation.
- What happens to the airways during an asthma attack.

Role of medications: understanding the difference between the following:
- Long-term control medications: prevent symptoms, often by reducing inflammation. Must be taken daily. Do not expect them to give quick relief.
- Quick-relief medications: SABAs relax airway muscles to provide prompt relief of symptoms. Do not expect them to provide long-term asthma control. Using SABA >2 days a week indicates the need for starting or increasing long-term control medications.

Patient skills
- Taking medications correctly.
  - Inhaler technique (demonstrate to the patient and have the patient return the demonstration).
  - Use of devices, as prescribed (eg, valved holding chamber [VHC] or spacer, nebulizer).
- Identifying and avoiding environmental exposures that worsen the patient’s asthma; eg, allergens, irritants or pollutants, tobacco smoke.
- Self-monitoring.
  - Assess level of asthma control.
  - Monitor symptoms and, if prescribed, PEF measures.
  - Recognize early signs and symptoms of worsening asthma.
- Using a written asthma action plan to know when and how to do the following:
  - Take daily actions to control asthma.
  - Adjust medication in response to signs of worsening asthma.
- Seeking medical care as appropriate.

Encourage patients’ adherence to the written asthma action plan by doing the following:
- Choose treatment that achieves outcomes and addresses preferences that are important to the patient, and reminding patients that adherence will help them achieve the outcomes they want.
- Review with the patient at each visit the success of the treatment plan to achieve asthma control and make adjustments as needed.
- Review patients’ concerns about their asthma or treatment at every visit. Inquire about any difficulties encountered in adhering to the written asthma action plan.
- Assess the patient’s and family’s level of social support, and encourage family involvement.
- Tailor the self-management approach to the needs and literacy levels of the patient, and maintain sensitivity to cultural beliefs and ethnocultural practices.

Encourage health care provider and health care system support of the therapeutic partnership by doing the following:
- Incorporate effective clinician education strategies, such as interactive formats, practice-based case studies, and multidimensional teaching approaches that reinforce guideline-based care.
- Provide communication skills training to clinicians to enhance competence in caring for all patients, especially multicultural populations.
- Use systems approaches, such as clinical pathways and clinical information system prompts, to improve the quality of asthma care and to support clinical care decision-making.

Component 3: control of environmental factors and comorbid conditions that affect asthma
If patients who have asthma are exposed to irritants or inhalant allergens to which they are sensitive, their asthma symptoms may increase and precipitate an asthma exacerbation. Substantially reducing exposure to these factors may reduce inflammation, symptoms, and need for medication. Several comorbid conditions can impede asthma management. Recognition and treatment of these conditions may improve asthma control. See Fig 3 for questions related to environmental exposures and comorbid conditions.
My Asthma Action Plan

Patient Name: __________________________
Medical Record #: ___________________

Physician’s Name: __________________________
DOB: __________________________

Physician’s Phone #: __________________________
Completed by: __________________________
Date: __________________________

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<th>Long-Term-Control Medicines</th>
<th>How Much To Take</th>
<th>How Often</th>
<th>Other Instructions</th>
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<th>Quick-Relief Medicines</th>
<th>How Much To Take</th>
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NOTE: If this medicine is needed frequently, call physician to consider increasing long-term-control medications.

Special instructions when I feel
- good,
- not good, and
- awful.

I feel good.
(My peak flow is in the GREEN zone.)

My symptoms may include one or more of the following:
- Wheeze
- Tight chest
- Cough
- Shortness of breath
- Waking up at night with asthma symptoms
- Decreased ability to do usual activities

PREVENT asthma symptoms everyday:
- Take my long-term-control medicines (above) every day.
- Before exercise, take ______ puffs of ______.
- Avoid things that make my asthma worse like:

CAUTION. I should continue taking my long-term-control asthma medicines every day AND:
- Take

If I still do not feel good, or my peak flow is not back in the Green Zone within 1 hour, then I should:
- Increase
- Add
- Call

MEDICAL ALERT! Get help!
- Take
- until I get help immediately.
- Take

Call 9-1-1 if you have trouble walking or talking due to shortness of breath or lips or fingernails are gray or blue.

Danger! Get help immediately!

Adapted and reprinted with permission from the Regional Asthma Management and Prevention Initiative, a program of the Public Health Institute.


FIG 5. Sample asthma action plan—adult.
Child Asthma Action Plan
0–5 years of age

Health Care Provider’s Name: _________________________
Health Care Provider’s Phone #: _________________________
Completed by: _________________________
Date: _________________________

Long-Term-Control Medicines
(bbe every day to stay healthy)

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<th>How Often</th>
<th>Other Instructions</th>
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Quick-Relief Medicines

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Child is well
and has no asthma
symptoms, even
during active play.

Child is not well
and has
asthma symptoms that may include:

- Coughing
- Wheezing
- Runny nose or other cold symptoms
- Breathing harder or faster
- Awakening due to coughing or difficulty breathing
- Playing less than usual
- Other symptoms that may indicate that your child is having
  trouble breathing may include difficulty feeding (grunting
  sounds, poor sucking, changes in sleep pattern, cranky
  and tired, decreased appetite.

Child feels awful!
Warning signs
may include:

- Child’s wheeze, cough, or difficulty breathing continues
  or worsens, even after giving yellow zone medicines.
- Child’s breathing is so hard that he/she is having trouble
  talking/eating/walking/going:
- Child is drowsy or less alert than normal.

Medical Alert! Get help!

- Call 9-1-1 if:
  - The child’s skin is sucked in around neck and ribs, or
  - Lips and/or fingernails are grey or blue, or
  - Child doesn’t respond to you.

Prevent asthma symptoms every day:

- Give the above long-term-control medicines every day.
- Avoid things that make the child’s asthma worse.
  - Avoid tobacco smoke; ask people to smoke outside.

CAUTION: Take action by continuing to give regular asthma
medicines every day:

- Give __________ (include dose and frequency)
- If the child is not in the Green Zone and still has symptoms after
  1 hour, then:
  - Give more __________ (include dose and frequency)
  - Call __________ (include dose and frequency)
  - Give __________ (include dose and frequency)

Danger! Get help immediately!

Adapted and reprinted with permission from the Regional Asthma Management and Prevention Initiative, a program of the Public
Health Institute.
Source: http://www.calasthma.org/uploads/resources/actionplan.pdf; San Francisco Bay Area Regional Asthma Management

FIG 6. Sample asthma action plan—child.
Allergens and irritants

Evaluate the potential role of allergens (particularly inhalant allergens) and pollutants or irritants.

- Identify allergen and irritant exposures. The most important allergens for both children and adults appear to be those that are inhaled.
- For patients who have persistent asthma, use skin testing or in vitro testing to assess sensitivity to perennial indoor allergens. Assess the significance of positive tests in the context of the person’s history of symptoms when exposed to the allergen.

Advise patients who have asthma to reduce exposure to allergens and pollutants or irritants to which they are sensitive.

- See Fig 9 for a sample patient information sheet.
- Effective allergen avoidance requires a multifaceted, comprehensive approach; single steps alone are generally ineffective. Multifaceted allergen control education programs provided in the home setting can help patients reduce exposures to cockroach, dust mite, and rodent allergens and, consequently, improve asthma control.
- Advise patients who have severe persistent asthma, nasal polyps, or a history of sensitivity to aspirin or nonsteroidal anti-inflammatory drugs about their risk of severe and even fatal exacerbations from using these drugs.
- Indoor air-cleaning devices (high-efficiency particulate air and electrostatic precipitating filters) cannot substitute for more effective dust mite and cockroach control measures because these particles do not remain airborne. The devices can reduce airborne dog and cat allergens, mold spores, and particulate tobacco smoke; however, most studies do not show an effect on symptoms or lung function.
- Use of humidifiers or evaporative (swamp) coolers is not generally recommended in homes of patients who are sensitive to dust mites or mold.
Consider subcutaneous allergen immunotherapy for patients who have persistent asthma when there is clear evidence of a relationship between symptoms and exposure to an allergen to which the patient is sensitive. Evidence is strongest for use of subcutaneous immunotherapy for single allergens, particularly house dust mites, animal dander, and pollen. The role of allergy in asthma is greater in children than in adults. If use of allergen immunotherapy is elected, it should be administered only in a physician’s office where facilities and trained personnel are available to treat any life-threatening reaction that can, but rarely does, occur.

Consider inactivated influenza vaccination for patients who have asthma. This vaccine is safe for administration to children older than 6 months and adults, and the Advisory Committee on Immunization Practices of the Centers for Disease Control and Prevention recommends vaccination for persons who have asthma because they are considered to be at risk for complications from influenza. However, the vaccine should not be given with the expectation that it will reduce either the frequency or severity of asthma exacerbations during the influenza season.

Dietary factors have an inconclusive role in asthma. Food allergies are rarely an aggravating factor in asthma. An exception is that sulfites in foods (eg, shrimp, dried fruit, processed potatoes, beer, and wine) can precipitate asthma symptoms in people who are sensitive to these food items. Furthermore, individuals who have both food allergy and asthma are at increased risk for fatal anaphylactic reactions to the food to which they are sensitized.

Comorbid conditions
Identify and treat comorbid conditions that may impede asthma management. If these conditions are treated appropriately, asthma control may improve.

- Allergic bronchopulmonary aspergillosis may be considered in patients who have asthma and a history of pulmonary infiltrates, have IgE sensitization to Aspergillus, and/or are corticosteroid dependent. Diagnostic criteria include a positive immediate skin test and elevated serum IgE and/or IgG to Aspergillus, total serum IgE >417 IU (1000 ng/mL), and central bronchiectasis. Treatment is prednisone, initially 0.5 mg per kilogram with gradual tapering. Azole...
antifungal agents as adjunctive therapy may also be helpful.

- **Gastroesophageal reflux** treatment may benefit patients who have asthma and complain of frequent heartburn or pyrosis, particularly those who have frequent nighttime asthma symptoms. Even in the absence of suggestive GERD symptoms, consider evaluation for GERD in patients who have poorly controlled asthma, especially with nighttime symptoms. Treatment includes avoiding heavy meals, fried foods, caffeine, and alcohol; avoiding food and drink within 3 hours of retiring; elevating the head of the bed on 6-inch to 8-inch blocks; and using proton pump inhibitor medication.

- **Obese or overweight patients** who have asthma may be advised that weight loss, in addition to improving overall health, might also improve asthma control.

- **Obstructive sleep apnea** may be considered in patients who have not well controlled asthma, particularly those who are overweight or obese. Treatment for OSA is nasal continuous positive airway pressure. However, this treatment may disrupt the sleep of patients with asthma who do not also have OSA. Accurate diagnosis is important.

- **Rhinitis or sinusitis** symptoms or diagnosis should be evaluated in patients who have asthma, because the interrelationship of the upper and lower airway suggests that therapy for the upper airway will improve asthma control. Treatment of allergic rhinitis includes intranasal corticosteroids, antihistamine therapy, and the consideration of immunotherapy. Treatment of sinusitis includes intranasal corticosteroids and antibiotics. Evidence is inconclusive regarding the effect on asthma of sinus surgery in patients who have chronic rhinosinusitis.

- **Stress and depression** should be considered in patients who have asthma that is not well controlled. Additional education to improve self-management and coping skills may be helpful.

### Component 4: medications

Medications for asthma are categorized into 2 general classes: long-term control medication and quick-relief medication. Selection of medications includes...
You can help prevent asthma episodes by staying away from things that make your asthma worse. This guide suggests many ways to help you do this. You need to find out what makes your asthma worse. Some things that make asthma worse for some people are not a problem for others. You do not need to do all of the things listed in this guide. Look at the things listed below. Put a check next to the ones that you know make your asthma worse, particularly if you are allergic to these things. Then, decide with your doctor what steps you will take. Start with the things in your bedroom that bother your asthma. Try something simple first.

**Tobacco smoke**
- If you smoke, ask your doctor for ways to help you quit. Ask family members to quit smoking, too.
- Do not allow smoking in your home, car, or around you.
- Be sure no one smokes at a child’s day care center or school.

**Dust mites**
- Many people who have asthma are allergic to dust mites. Dust mites are like tiny bugs you cannot see that live in cloth or carpet.
- Things that will help the most:
  - Encourage your mattress in a special dust mite-proof cover.
  - Encourage your pillow in a special dust mite-proof cover or wash the pillow each week in hot water. Water must be hotter than 130 °F to kill the mites. Cooler water used with detergent and bleach can also be effective.
  - Wash the sheets and blankets on your bed each week in hot water.
- Other things that can help:
  - Reduce indoor humidity to or below 50%, ideally 30% to 50%. Dehumidifiers or central air conditioners can do this.
  - Try not to sleep or lie on cloth-covered cushions or furniture.
  - Remove carpets from your bedroom and those laid on concrete, if you can.
  - Keep stuffed toys out of the bed, or wash the toys weekly in hot water or in cooler water with detergent and bleach. Placing toys weekly in a dryer or freezer may help. Prolonged exposure to dry heat or freezing can kill mites but does not remove allergen.

*To find out where to get products mentioned in this guide, call:*
- Asthma and Allergy Foundation of America (800–727–8462)
- National Jewish Medical and Research Center (Lung Line) (800–222–5664)
- Allergy & Asthma Network Mothers of Asthmatics (800–878–4403)
- American College of Allergy, Asthma, and Immunology (800–842–7777)
- American Academy of Allergy, Asthma, and Immunology (800–222–5664)

**Animal dander**
- Some people are allergic to the flakes of skin or dried saliva from animals.
- The best thing to do:
  - Keep pets with fur or hair out of your home.
  - If you can’t keep the pet outdoors, then:
    - Keep the pet out of your bedroom, and keep the bedroom door closed.
    - Remove carpets and furniture covered with cloth from your home. If that is not possible, keep the pet out of the rooms where these are.

**Cockroaches**
- Many people with asthma are allergic to the droppings and remains of cockroaches.
- Keep all food out of your bedroom.
- Keep food and garbage in closed containers (never leave food out).
- Use poison baits, powders, gels, or paste (for example, boric acid). You can also use traps.
- Keep all food out of your bedroom.
- If a spray is used to kill roaches, stay out of the room until it dries away.

**Vacuum cleaning**
- Try to get someone else to vacuum for you once or twice a week. If you can: Stay out of rooms while they are being vacuumed and for a short while afterward.
- If you vacuum, use a dust mask (from a hardware store), a central cleaner with the collecting bag outside the home, or a vacuum cleaner with a high-efficiency particulate air (HEPA) filter or a double-layered bag.*

**Indoor mold**
- Fix leaking faucets, pipes, or other sources of water.
- Clean moldy surfaces.
- Dehumidify basements if possible.

**Poison and outdoor mold**
- During your allergy season (when pollen or mold spore counts are high):
  - Try to keep your windows closed.
  - If possible, stay indoors with windows closed during the weekday and afternoons, if you can. Pollen and some mold spore counts are highest at that time.
  - Ask your doctor whether you need to take or increase anti-inflammatory medicine before your allergy season starts.

**Smoke, strong odors, and sprays**
- If possible, do not use a wood-burning stove, kerosene heater, fireplace, unvented gas stove, or heater.
- Try to stay away from strong odors and sprays, such as perfume, talcum powder, hair spray, paints, new carpet, or particle board.

**Exercise or sports**
- You should be able to be active without symptoms. See your doctor if you have asthma symptoms when you are active—such as when you exercise, do sports, play, or work hard.
- Ask your doctor about taking medicine before you exercise to prevent symptoms.
- Warm up for a period before you exercise.
- Check the air quality index and try not to work or play hard outside when the air pollution or pollen levels (if you are allergic to the pollen) are high.

**Other things that can make asthma worse**
- **Sulfites in foods:** Do not drink beer or wine or eat shrimp, dried fruit, or processed potatoes if they cause asthma symptoms.
- **Cold air:** Cover your nose and mouth with a scarf on cold or wintry days.
- **Other medicines:** Tell your doctor about all the medicines you may take. Include cold medicines, aspirin, and even eye drops.

FIG 9. How to control things that make your asthma worse.
consideration of the general mechanisms and role of the medication in therapy, delivery devices, and safety.

**General mechanisms and role in therapy**

**Long-term control medications** are used daily to achieve and maintain control of persistent asthma. These medications are most effective at those that attenuate the underlying inflammation characteristic of asthma. Long-term control medications include the following (listed in alphabetical order):

- **Corticosteroids** are anti-inflammatory medications that reduce airway hyperresponsiveness, inhibit inflammatory cell migration and activation, and block late-phase reaction to allergen. ICSs are the most consistently effective long-term control medication at all steps of care for persistent asthma, and ICSs improve asthma control more effectively in both children and adults than leukotriene receptor antagonists (LTRAs) or any other single, long-term control medication do. ICSs reduce impairment and risk of exacerbations, but ICSs do not appear to alter the progression or underlying severity of the disease in children. Short courses of oral systemic corticosteroids are often used to gain prompt control of asthma. Oral systemic corticosteroids are used long-term to treat patients who require step 6 care (for severe persistent asthma).

- **Cromolyn sodium and nedocromil** stabilize mast cells and interfere with chloride channel function. They are used as alternative, but not preferred, medication for patients requiring step 2 care (for mild persistent asthma). They also can be used as preventive treatment before exercise or unavoidable exposure to known allergens.

- **Immunomodulators.** Omalizumab (anti-IgE) is a mAb that prevents binding of IgE to the high-affinity receptors on basophils and mast cells. Omalizumab is used as adjunctive therapy for patients ≥12 years of age who have sensitivity to relevant allergens (eg, dust mite, cockroach, cat, or dog) and who require step 5 or 6 care (for severe persistent asthma). Clinicians who administer omalizumab should be prepared and equipped to identify and treat anaphylaxis that may occur.

- **Leukotriene modifiers** interfere with the pathway of leukotriene mediators, which are released from mast cells, eosinophils, and basophils. These medications include LTRAs (montelukast and zafirlukast) and a 5-lipoxygenase inhibitor (zileuton). LTRAs are alternative, but not preferred, therapy for the treatment of patients who require step 2 care (for mild persistent asthma). LTRAs also can be used as adjunctive therapy with ICSs, but for youths ≥12 years of age and adults, they are not preferred adjunctive therapy compared with the addition of LABAs. LTRAs can attenuate EIB. Zileuton can be used as alternative, but not preferred, adjunctive therapy in adults; liver function monitoring is essential.

- **Long-acting β₂-agonists** (salmeterol and formoterol) are inhaled bronchodilators that have a duration of bronchodilation of at least 12 hours after a single dose.
  - Long-acting β₂-agonists are not to be used as monotherapy for long-term control of asthma.
  - Long-acting β₂-agonists are used in combination with ICSs for long-term control and prevention of symptoms in moderate or severe persistent asthma (step 3 care or higher in children ≥5 years of age and adults and step 4 care or higher in children 0-4 years of age, although few data are available for children 0-4 years).
  - Of the adjunctive therapies available, LABA is the preferred therapy to combine with ICS in youths ≥12 years of age and adults.
  - A LABA may be used before exercise to prevent EIB, but duration of action does not exceed 5 hours with chronic, regular use. Frequent or chronic use before exercise is discouraged, because this may disguise poorly controlled persistent asthma. See also the section “Safety Issues for ICSs and LABAs.”

- **Methylxanthines.** Sustained-release theophylline is a mild to moderate bronchodilator used as alternative, not preferred therapy for step 2 care (for mild persistent asthma) or as adjunctive therapy with ICS in patients ≥5 years of age. Theophylline may have mild anti-inflammatory effects. Monitoring of serum theophylline concentration is essential.

**Quick-relief medications** are used to treat acute symptoms and exacerbations. They include the following (listed in alphabetical order):

- **Anticholinergics** inhibit muscarinic cholinergic receptors and reduce intrinsic vagal tone of the airway. Ipratropium bromide provides additive benefit to SABA in moderate or severe exacerbations in the emergency care setting, not the hospital setting. Ipratropium bromide may be used as an alternative bronchodilator for patients who do not tolerate SABA, although it has not been compared to SABAs.

- **Short-acting β₂-agonists**—albuterol, levalbuterol, and pirbuterol—are bronchodilators that relax smooth muscle. They are the treatment of choice for relief of acute symptoms and prevention of EIB. Increasing use of SABA treatment or the use of SABA >2 days a week for symptom relief (not prevention of EIB) generally indicates inadequate asthma control and the need for initiating or intensifying anti-inflammatory therapy. Regularly scheduled, daily, chronic use of SABA is not recommended.

- **Systemic corticosteroids.** Although not short-acting, oral systemic corticosteroids are used for moderate and severe exacerbations in addition to SABA to speed recovery and to prevent recurrence of exacerbations.
Complementary and alternative medications and interventions generally have insufficient evidence to permit recommendations. Because as much as 1/3 of the US population uses complementary alternative healing methods, it is important to discuss their use with patients.

- **Ask patients about all the medications and interventions they are using.** Some cultural beliefs and practices may be of no harm and can be integrated into the recommended asthma management strategies, but it is important to advise patients that alternative healing methods are not substitutes for recommended therapeutic approaches. Clinical trials on safety and efficacy are limited, and their scientific basis has not been established.

- **Evidence is insufficient to recommend or not recommend most complementary and alternative medications or treatments for asthma.** These include chiropractic therapy, homeopathy and herbal medicine, and breathing or relaxation techniques. Acupuncture is not recommended for the treatment of asthma.

- **Patients who use herbal treatments for asthma should be cautioned** about the potential for harmful ingredients and for interactions with recommended asthma medications.

### Delivery devices for inhaled medications

**Patients should be instructed in the use of inhaled medications, and patients’ technique should be reviewed at every patient visit.** The major advantages of delivering drugs directly into the lungs via inhalation are that higher concentrations can be delivered more effectively to the airways and that systemic side effects are lessened. Inhaled medications, or aerosols, are available in a variety of devices that differ in the technique required. See Fig 10 for a summary of issues to consider for different devices.

### Safety issues for ICSs and LABAs

**ICs**

- Inhaled corticosteroids are the preferred long-term control therapy in children of all ages and adults. In general, ICSs are well tolerated and safe at the recommended dosages.
Most benefits of ICS for patients who have mild or moderate asthma occur at the low-dose to medium-dose ranges. Data suggest higher doses may further reduce the risk of exacerbations. Furthermore, higher doses are beneficial for patients who have more severe asthma. The risk of adverse effects increases with the dose.

High doses of ICS administered for prolonged periods (eg, >1 year) have significantly less potential than oral systemic corticosteroids for having adverse effects. High doses of ICS used for prolonged periods (eg, >1 year), particularly in combination with frequent courses of oral corticosteroids, may be associated with risk of posterior subcapsular cataracts or reduced bone density. Slit-lamp eye examination and bone densitometry may be considered. For adult patients, consider supplements of calcium and vitamin D, particularly in perimenopausal women. For children, age-appropriate dietary intake of calcium and vitamin D should be reviewed with parents or caregivers.

ICSs and linear growth in children

To reduce the potential for adverse effects, the following measures are recommended:

- Advise patients to use spacers or VHCs with nonbreath-activated metered-dose inhalers (MDIs) to reduce local side effects. There are no clinical data on use of spacers or VHCs with ultrafine particle hydrofluoroalkane MDIs.
- Advise patients to rinse the mouth (rinse and spit) after inhalation.
- Use the lowest dose of ICS that maintains asthma control. Evaluate the patient’s inhaler technique and adherence, as well as environmental control measures, before increasing the dose.
- Consider adding a LABA, or alternative adjunctive therapy, to a low or medium dose of ICS rather than using a higher dose of ICS to maintain asthma control.

To the potential risks of ICSs are well balanced by their benefits.
Poorly controlled asthma may delay growth. Children who have asthma tend to have longer periods of reduced growth rates before puberty.

Growth rates are highly variable in children. Short-term evaluation may not be predictive of final adult height attained.

The potential for adverse effects on linear growth from ICS appear to be dose-dependent. In treatment of children who have mild or moderate persistent asthma, low-dose to medium-dose ICS therapy may be associated with a possible, but not predictable, adverse effect on linear growth (approximately 1 cm). The effect on growth velocity appears to occur in the first several months of treatment and is generally small and not progressive. The clinical significance of this potential systemic effect has yet to be determined.

In general, the efficacy of ICSs is sufficient to outweigh any concerns about growth or other systemic effects. However, ICSs should be titrated to as low a dose as needed to maintain good control of the child’s asthma, and children receiving ICSs should be monitored for changes in growth by using a stadiometer.

LABAs

The addition of LABA (salmeterol or formoterol) to the treatment of patients who require more than low-dose ICS alone to control asthma improves lung function, decreases symptoms, and reduces exacerbations and use of SABA for quick relief in most patients to a greater extent than doubling the dose of ICSs.

A large clinical trial comparing daily treatment with salmeterol or placebo added to usual asthma therapy resulted in an increased risk of asthma-related deaths in patients treated with salmeterol (13 deaths among 13,176 patients treated for 28 weeks with salmeterol vs 3 deaths among 13,179 patients treated with placebo). In addition, increased numbers of severe asthma exacerbations were noted in...
The pivotal trials submitted to the US Food and Drug Administration (FDA) for formoterol approval, particularly in the arms of the trials with higher dose formoterol. Thus, the FDA determined that a Black Box warning was warranted on all preparations containing a LABA. Daily use of LABA generally should not exceed 100 mcg salmeterol or 24 mcg formoterol.

### Stepwise approach for managing asthma

**Principles of the stepwise approach**

A stepwise approach to managing asthma is recommended to gain and maintain control of asthma in both the impairment and risk domains. These domains may respond differentially to treatment.

For children, see Figs 11 to 13.

For adults, see Figs 14 to 16.

For medication dosages, see Figs 17 to 19.

The stepwise approach incorporates all 4 components of care: assessment of severity to initiate therapy or assessment of control to monitor and adjust therapy; patient education; environmental control measures and management of comorbid conditions at every step; and selection of medication.
FIG 13. Stepwise approach for managing asthma long-term in children 0 to 4 years of age and 5 to 11 years of age. PRN, As necessary; q, every.
The type, amount, and scheduling of medication is determined by the level of asthma severity or asthma control.

- Therapy is increased (stepped up) as necessary and decreased (stepped down) when possible.
- Because asthma is a chronic inflammatory disorder, persistent asthma is most effectively controlled with daily long-term control medication directed toward suppressing inflammation. ICSs are the most consistently effective anti-inflammatory therapy for all age groups, at all steps of care for persistent asthma.
- Selection among alternative treatment options is based on consideration of treatment effectiveness for the domain of particular relevance to the patient (impairment, risk, or both), the individual patient’s history of previous response to therapies (sensitivity and responsiveness to different asthma medications can vary among patients), and the willingness and ability of the patient and family to use the medication.
- Once asthma control is achieved, monitoring and followup are essential, because asthma often varies over time. A step up in therapy may be needed, or a step down may be possible, to identify the minimum medication necessary to maintain control.

The stepwise approach and recommended treatments are meant to assist, not replace, the clinical decision-making necessary to determine the most

---

### Assessing severity and initiating treatment for patients who are not currently taking long-term control medications

<table>
<thead>
<tr>
<th>Components of Severity</th>
<th>Classification of Asthma Severity</th>
<th>Intermittent</th>
<th>Mild</th>
<th>Moderate</th>
<th>Severe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Symptom</td>
<td>&gt;2 days/week</td>
<td>&gt;2 days/week but not daily</td>
<td>Daily</td>
<td>Throughout the day</td>
<td></td>
</tr>
<tr>
<td>Nighttime awakenings</td>
<td>≤2x/month</td>
<td>3–4x/month</td>
<td>&gt;1x/week but not nightly</td>
<td>Often 7x/week</td>
<td></td>
</tr>
<tr>
<td>Short-acting β₂-agonist use for symptom control (not prevention of EIB)</td>
<td>≤2 days/week</td>
<td>&gt;2 days/week but not daily, and not more than 1x on any day</td>
<td>Daily</td>
<td>Several times per week</td>
<td></td>
</tr>
<tr>
<td>Interference with normal activity</td>
<td>None</td>
<td>Minor limitation</td>
<td>Some limitation</td>
<td>Extremely limited</td>
<td></td>
</tr>
</tbody>
</table>

#### Lung function

- Normal FEV₁ between exacerbations
- FEV₁ > 80% predicted
- FEV₁/FVC normal

#### Risk

- Exacerbations requiring oral systemic corticosteroids
- 0–1/year (see note)
- >2/year (see note)

Relative annual risk of exacerbations may be related to FEV₁.

Consider severity and interval since last exacerbation. Frequency and severity may fluctuate over time for patients in any severity category.

**Fig 14.** Classifying asthma severity and initiating treatment in youths ≥12 years of age and adults.*
appropriate treatment to meet the individual patient’s needs and circumstances.

Referral to an asthma specialist for consultation or comanagement is recommended if there are difficulties achieving or maintaining control of asthma, if the patient required >2 bursts of oral systemic corticosteroids in 1 year or has an exacerbation requiring hospitalization, if step 4 care or higher is required (step 3 care or higher for children 0-4 years of age), if immunotherapy or omalizumab is considered, or if additional testing is indicated.

To achieve control of asthma, the following sequence of activities is recommended:

- For patients who are not already taking long-term control medications, assess asthma severity and initiate therapy according to the level of severity.
- For patients who are already taking long-term control medications, assess asthma control and step

---

**TABLE:** Components of Control

<table>
<thead>
<tr>
<th>Impairment</th>
<th>Classification of Asthma Control (≥12 years of age)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Well Controlled</td>
</tr>
<tr>
<td></td>
<td>≤2 days/week</td>
</tr>
<tr>
<td></td>
<td>1-3x/month</td>
</tr>
<tr>
<td></td>
<td>None</td>
</tr>
<tr>
<td></td>
<td>≥2 days/week</td>
</tr>
<tr>
<td>FEV₁ or peak flow</td>
<td>&gt;80% predicted/ personal best</td>
</tr>
<tr>
<td>Validated questionnaires</td>
<td>ATAQ ACT</td>
</tr>
<tr>
<td></td>
<td>≥20</td>
</tr>
<tr>
<td></td>
<td>≥3-4 ≤15</td>
</tr>
</tbody>
</table>

**Risk**

- Exacerbations requiring oral systemic corticosteroids: 0-1/year (see notes)
- Consider severity and interval since last exacerbation.

**Recommended Action for Treatment**

(See "Stepwise Approach for Managing Asthma" for treatment steps.)

- Maintain current step.
- Regular follow-up at every 1-6 months to maintain control.
- Consider step down if well controlled for at least 3 months.
- Step up 1 step.
- Re-evaluate in 2-6 weeks.
- For side effects, consider alternative treatment options.
- Consider short course of oral systemic corticosteroids.
- Step up 1-2 steps.
- Re-evaluate in 2 weeks.
- For side effects, consider alternative treatment options.

*ACQ values of 0.76-1.4 are indeterminate regarding well controlled asthma.

†Notes:
- The stepwise approach is meant to assist, not replace, the clinical decision-making required to meet individual patient needs.
- The level of control is based on the most severe impairment or risk category. Assess impairment domain by patient’s recall of previous 2-4 wk and by spirometry or peak flow measures. Symptom assessment for longer periods should reflect a global assessment, such as inquiring whether the patient’s asthma is better or worse since the last visit.
- Currently there are inadequate data to correspond frequencies of exacerbations with different levels of asthma control. In general, more frequent and severe exacerbations (eg, requiring urgent, unscheduled care, hospitalization, or ICU admission) indicate poorer disease control. For treatment purposes, patients who had ≥2 exacerbations requiring oral systemic corticosteroids in the past year may be considered the same as patients who have not-well controlled asthma, even in the absence of impairment levels consistent with not-well controlled asthma.
- Validated questionnaires for the impairment domain (the questionnaires do not assess lung function or the risk domain).

**FIG 15. Assessing asthma control and adjusting therapy in youths ≥12 years of age and adults.† ACQ, Asthma Control Questionnaire.**
Persistent Asthma: Daily Medication
Consult with asthma specialist if step 4 care or higher is required. Consider consultation at step 3.

Step 1
Preferred: Low-dose ICS
Alternative: Cromolyn, LTRA, Nedocromil, or Theophylline

Step 2
Preferred: Low-dose ICS + LABA
Alternative: Medium-dose ICS + either LTRA, Theophylline, or Zileuton

Step 3
Preferred: Medium-dose ICS + LABA
Alternative: Low-dose ICS + either LTRA, Theophylline, or Zileuton

Step 4
Preferred: High-dose ICS + LABA
AND Consider Omalizumab for patients who have allergies

Step 5
Preferred: High-dose ICS + LABA + oral corticosteroid
AND Consider Omalizumab for patients who have allergies

Step 6
Step up if needed
(first, check adherence, environmental control, and comorbid conditions)
Step down if possible
(and asthma is well controlled at least 3 months)

Assess control

FIG 16. Stepwise approach for managing asthma in youths ≥12 years of age and adults.* PRN, As necessary.

*Notes:
- The stepwise approach is meant to assist, not replace, the clinical decision-making required to meet individual patient needs.
- If alternative treatment is used and response is inadequate, discontinue it and use the preferred treatment before stepping up.
- Zileuton is a less desirable alternative because of limited studies as adjunctive therapy and the need to monitor liver function. Theophylline requires monitoring of serum concentration levels.
- In step 6, before oral corticosteroids are introduced, a trial of high-dose ICS + LABA + LTRA, theophylline, or zileuton may be considered, although this approach has not been studied in clinical trials.
- Step 1, 2, and 3 preferred therapies are based on Evidence A; step 3 alternative therapy is based on Evidence A for LTRA. Evidence B for theophylline, and Evidence D for zileuton. Step 4 preferred therapy is based on Evidence B, and alternative therapy is based on Evidence B for LTRA and theophylline and Evidence D for zileuton. Step 5 preferred therapy is based on Evidence B. Step 6 preferred therapy is based on (EPR-2 1997) and Evidence B for omalizumab.
- Immunotherapy for steps 2-4 is based on Evidence B for house dust mites, animal danders, and pollens; evidence is weak or lacking for molds and cockroaches. Evidence is strongest for immunotherapy with single allergens. The role of allergy in asthma is greater in children than in adults.
- Clinicians who administer immunotherapy or omalizumab should be prepared and equipped to identify and treat anaphylaxis that may occur.
- Alphabetical order is used when more than 1 treatment option is listed within either preferred or alternative therapy.

Each Step: Patient education, environmental control, and management of comorbidities.
Steps 2-4: Consider subcutaneous allergen immunotherapy for patients who have allergic asthma (see notes).

Quick-Relief Medication for All Patients
- SABA as needed for symptoms. Intensity of treatment depends on severity of symptoms: up to 3 treatments at 20-minute intervals as needed. Short course of oral systemic corticosteroids may be needed.
- Use of SABA >2 days a week for symptom relief (not prevention of EIB) generally indicates inadequate control and the need to step up treatment.

up therapy if the patient’s asthma is not well controlled on current therapy. Before stepping up, review the patient’s adherence to medications, inhaler technique, and environmental control measures.

- Evaluate asthma control in 2 to 6 weeks (depending on level of initial severity or control).
  - In general, classify the level of asthma control by the most severe indicator of impairment or risk.
  - The risk domain is usually more strongly associated with morbidity in young children than the impairment domain because young children are often symptom-free between exacerbations.
  - If office spirometry suggests worse control than other measures of impairment, consider fixed obstruction and reassess the other measures. If fixed obstruction does not explain the lack of control, step up therapy, because low FEV₁ is a predictor of exacerbations.
    - If the history of exacerbations suggests poorer control than does assessment of impairment, reassess impairment measures, and consider a step up in therapy. Review plans for handling exacerbations and include the use of oral systemic corticosteroids, especially for patients who have a history of severe exacerbations.
- If asthma control is not achieved with these actions, do the following:
  - Review the patient’s adherence to medications, inhaler technique, environmental control measures (or whether there are new exposures), and management of comorbid conditions.

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### Medication

**Inhaled LABAs**

<table>
<thead>
<tr>
<th>Medication</th>
<th>0-4 Years of age</th>
<th>5-11 Years of age</th>
<th>≥12 Years of age and adults</th>
<th>Potential adverse effects</th>
<th>Comments (not all inclusive)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salmeterol</td>
<td>NA</td>
<td>1 blister q 12 hours</td>
<td>1 blister q 12 hours</td>
<td>Tachycardia, skeletal muscle tremor, hypokalemia, prolongation of QTc interval in overdose.</td>
<td>Should not be used for acute symptom relief or exacerbations. Use only with ICSs. Decreased duration of protection against EIB may occur with regular use. Must children &lt;4 years of age cannot provide sufficient inspiratory flow for adequate lung delivery. Do not blow into inhaler after dose is activated. Each capsule is for single use only; additional doses should not be administered for at least 12 hours. Capsules should be used only with the inhaler and should not be taken orally.</td>
</tr>
</tbody>
</table>

**Combined medication**

<table>
<thead>
<tr>
<th>Medication</th>
<th>0-4 Years of age</th>
<th>5-11 Years of age</th>
<th>≥12 Years of age and adults</th>
<th>Potential adverse effects</th>
<th>Comments (not all inclusive)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fluticasone/salmeterol</td>
<td>NA</td>
<td>1 inhalation bid; dose depends on level of severity or control</td>
<td>1 inhalation bid; dose depends on level of severity or control</td>
<td>See notes for ICS and LABA.</td>
<td>There have been no clinical trials in children &lt;4 years of age. Must children &lt;4 years of age cannot provide sufficient inspiratory flow for adequate lung delivery. Do not blow into inhaler after dose is activated. 100/50 DPI or 40/21 HFA for patients who have asthma not controlled on low-to-medium-dose ICS. 290/50 DPI or 115/21 HFA for patients who have asthma not controlled on medium-dose to high-dose ICS.</td>
</tr>
<tr>
<td>Budenoside/ Formoterol</td>
<td>NA</td>
<td>2 puffs bid; dose depends on level of severity or control</td>
<td>2 puffs bid; dose depends on level of severity or control</td>
<td>See notes for ICS and LABA.</td>
<td>There have been no clinical trials in children &lt;4 years of age. Currently approved for use in youths ≥12 years of age. Dose for children 5-12 years of age based on clinical trials using DPI with slightly different delivery characteristics. 804.5 for patients who have asthma not controlled on low-dose to medium-dose ICS. 1604.5 for patients who have asthma not controlled on medium-dose to high-dose ICS.</td>
</tr>
</tbody>
</table>

**ICS (see Fig 18)**

**Oral systemic corticosteroids**

- **Methylprednisolone**
  - 2, 4, 8, 16, 32-mg tablets
  - 0.25-2 mg/kg daily in single dose or as needed for control

- **Prednisolone**
  - 5 mg tablets; 5 mg/g; 15 mg/5 cc
  - Short-course burst: 1-2 mg/kg/day, maximum 30 mg/day for 3-5 days
  - Short-course burst: 1-2 mg/kg/day
  - Short-course burst: to achieve control, 40-60 mg/kg as single or 2 divided doses for 3-10 days

**Potential adverse effects**

- Short-term use: reversible abnormalities in glucose metabolism, increased appetite, fluid retention, weight gain, mood alteration, hypertension, peptic ulcer, and rare erythema nodosum.
- Long-term use: adrenal axis suppression, growth suppression, dermal thinning, hypertrichosis, diabetes, Cushing syndrome, cataracts, muscle weakness, and in rare instances—impaired immune function.
- Consideration should be given to coexisting conditions that could be worsened by systemic corticosteroids, such as herpes virus infections, varicella zoster, tuberculosis, hypertension, peptic ulcer, diabetes mellitus, osteoporosis, and Cushingoid.

---

**Fig 17. Usual dosages for long-term control medications.**

- qod: every other day; q: every; QTc: Qwave and Twave corrected for rate; bid: twice a day; qid: 4 times a day; SC: subcutaneous; qhs: every night; ALT: alanine aminotransferase; SVT: supraventricular tachycardia.
<table>
<thead>
<tr>
<th>Medication</th>
<th>0-4 Years of age</th>
<th>5-11 Years of age</th>
<th>≥12 Years of age and adults</th>
<th>Potential adverse effects</th>
<th>Comments (not all inclusive)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cromolyn/nedocromil</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MDI 0.8 mg/puff</td>
<td>NA</td>
<td>2 puffs qid</td>
<td>2 puffs qid</td>
<td>Cough and irritation.</td>
<td>One dose of cromolyn before exercise or allergen exposure provides effective prophylaxis for 1-2 hours. Not as effective as inhaled β2-agonists for EB as SABA.</td>
</tr>
<tr>
<td>Nebulizer 20 mg/ampule</td>
<td>1 ampule qid</td>
<td>1 ampule qid</td>
<td>1 ampule qid</td>
<td>15% to 20% of patients complain of an unpleasant taste from nedocromil.</td>
<td>4-week to 6-week trial of cromolyn or nedocromil may be needed to determine maximum benefit.</td>
</tr>
<tr>
<td>Nedocromil</td>
<td>NA &lt;2 years of age</td>
<td>2 puffs qid</td>
<td>2 puffs qid</td>
<td>Safety is the primary advantage of these agents.</td>
<td>Dose by MDI may be inadequate to affect hyperresponsiveness.</td>
</tr>
<tr>
<td>MDI 1.75 mg/puff</td>
<td>NA &lt;6 years of age</td>
<td>2 puffs qid</td>
<td>2 puffs qid</td>
<td></td>
<td>Once control is achieved, the frequency of dosing may be reduced.</td>
</tr>
<tr>
<td>Immunomodulators (Anti-IgE)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Subcutaneous injection. 150 mg/1.2 mL after reconstitution with 1.4 mL sterile water for injection</td>
<td>NA</td>
<td>NA</td>
<td>150-375 mg SC q 2-4 wk, depending on body weight and pretreatment serum IgE level</td>
<td>Pain and bruising of injection sites in 5% to 20% of patients.</td>
<td>Do not administer more than 150 mg per injection site.</td>
</tr>
<tr>
<td>Leukotriene modifiers (LTRA)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Montelukast</td>
<td>4 mg qhs or 5 mg chewable tablet</td>
<td>4 mg qhs (1-5 years of age)</td>
<td>10 mg qhs (6-14 years of age)</td>
<td>No specific adverse effects have been identified.</td>
<td>Rare cases of Churg-Strauss have occurred, but the association is unclear.</td>
</tr>
<tr>
<td></td>
<td>4 mg granule packets</td>
<td></td>
<td></td>
<td></td>
<td>Montelukast exhibits a flat dose-response curve. Doses &gt;10 mg will not produce a greater response in adults.</td>
</tr>
<tr>
<td></td>
<td>10 mg tablet</td>
<td></td>
<td></td>
<td></td>
<td>No more efficacious than placebo in infants ages 6-24 months.</td>
</tr>
<tr>
<td></td>
<td>Zafirlukast</td>
<td>10 mg tablet</td>
<td>10 mg bid (7-11 years of age)</td>
<td>Postmarketing surveillance has reported cases of reversible hepatitis and, rarely, irreversible hepatic failure resulting in death and liver transplantation.</td>
<td>As long term control therapy, may attenuate exercise-induced bronchospasm in some patients, but less effective than ICS therapy.</td>
</tr>
<tr>
<td></td>
<td>20 mg tablet</td>
<td></td>
<td></td>
<td></td>
<td>For zafirlukast, administration with meals decreases bioavailability; take at least 1 hour before or 2 hours after meals.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Zafirlukast is a microsomal P450 enzyme inhibitor that can inhibit the metabolism of warfarin and theophylline. Doses of these drugs should be monitored accordingly.</td>
</tr>
<tr>
<td>Leukotriene modifiers (5-Lipoxygenase Inhibitor)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Zileuton</td>
<td>650-mg tablet</td>
<td>NA</td>
<td>2400 mg daily (give tablets qid)</td>
<td>Elevation of liver enzymes has been reported. Limited case reports of reversible hepatitis and hyperbilirubinemia.</td>
<td>Monitor hepatic enzymes (ALT). Warn patients to discontinue use if they experience signs and symptoms of liver dysfunction.</td>
</tr>
<tr>
<td>Methyloxanthines</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Theophylline</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Liquids, sustained-release tablets, and capsules</td>
<td>Starting dose 10 mg/kg/d; usual maximum: &lt;1 year of age: 0.2 mg/kg/d; 1 year or older: 5 mg/kg/d</td>
<td>Starting dose 10 mg/kg/d; usual maximum: 16 mg/kg/d</td>
<td>Starting dose 10 mg/kg/d to 300 mg maximum; usual maximum: 800 mg/d</td>
<td>Dose-related acute toxicities include tachycardia, nausea and vomiting, tachyarrhythmias (SVT), central nervous system stimulation, headache, seizures, hemorrhages, hyperglycemia, and hypokalemia.</td>
<td>Adjust dosage to achieve serum concentration of 5-15 mg/mL at steady-state (at least 48 hours on same dosage).</td>
</tr>
<tr>
<td></td>
<td>≥1 year of age: 16 mg/kg/d</td>
<td></td>
<td></td>
<td></td>
<td>Because of wide interpatient variability in theophylline metabolic clearance, routine serum theophylline level monitoring is essential.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Patients should be told to discontinue if they experience toxicity.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Various factors (diet, food, febrile illness, age, smoking, and other medications) can affect serum concentrations. See EPR-3 Full Report 2007 and package inserts for details.</td>
</tr>
</tbody>
</table>

FIG 17. Continued.
<table>
<thead>
<tr>
<th>Drug</th>
<th>Low daily dose</th>
<th>Medium daily dose</th>
<th>High daily dose</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Child 0-4 years of age</td>
<td>Child 5-11 years of age</td>
<td>≥12 Years of age and adults</td>
</tr>
<tr>
<td></td>
<td>mg</td>
<td>mg</td>
<td>mg</td>
</tr>
<tr>
<td>Beclometasone HFA</td>
<td>40 or 80 mg</td>
<td>80-160 mg</td>
<td>80-240 mg</td>
</tr>
<tr>
<td>Budesonide DPI</td>
<td>90, 180, or 200 mg</td>
<td>180-400 mg</td>
<td>180-600 mg</td>
</tr>
<tr>
<td>Budesonide Inhalated Suspension for Nebulization</td>
<td>0.25-0.5 mg</td>
<td>0.5 mg</td>
<td>NA</td>
</tr>
<tr>
<td>Flunisolide</td>
<td>250 mcg</td>
<td>500-750 mg</td>
<td>500-1000 mg</td>
</tr>
<tr>
<td>Flunisolide HFA</td>
<td>80 mcg</td>
<td>160 mcg</td>
<td>320 mcg</td>
</tr>
<tr>
<td>Fluticasone</td>
<td>HFA/DPI 44, 116, or 220 mg</td>
<td>88-176 mg</td>
<td>86-264 mg</td>
</tr>
<tr>
<td>DPI 50, 100, or 250 mcg/ium Inhalation</td>
<td>176 mg</td>
<td>100-200 mg</td>
<td>100-300 mg</td>
</tr>
<tr>
<td>Mometasone DPI</td>
<td>200 mg</td>
<td>NA</td>
<td>200 mg</td>
</tr>
<tr>
<td>Triamcinolone Acetonide</td>
<td>75 mcg</td>
<td>300-900 mg</td>
<td>300-750 mg</td>
</tr>
</tbody>
</table>

**Therapeutic issues:**

- The most important determinant of appropriate dosing is the clinician’s judgment of the patient's response to therapy. The clinician must monitor the patient’s response on several clinical parameters and adjust the dose accordingly. Once control of asthma is achieved, the dose should be carefully titrated to the minimum dose required to maintain control.

- Preparations are not interchangeable on a mg or per-puff basis. This figure presents estimated comparable daily doses. See EPRI 3 Full Report 2007 for full discussion.

- Some doses may be outside package labeling, especially in the high-dose range. Budesonide nebulizer suspension is the only ICS with FDA-approved labeling for children <4 years of age.

- For children <4 years of age: The safety and efficacy of ICSs in children <1 year has not been established. Children <4 years of age generally require delivery of ICS (budesonide and fluticasone HFA) through a face mask that should fit snugly over the nose and mouth and avoid nebulizing in the eyes. Wash face after each treatment to prevent local corticosteroid side effects. For budesonide, the dose may be administered 1-3 times daily. Budesonide suspension is compatible with albuterol, ipratropium, and levosalbuterol nebulizer solutions in the same nebulizer. Use only jet nebulizers, because ultrasonic nebulizers are ineffective for suspensions. For fluticasone HFA, the dose should be divided 2 times daily; the low dose for children <4 years of age is higher than for children 5-11 years of age because of lower dose delivered with face mask and data on efficacy in young children.

**Potential adverse effects of ICSs:**

- Cough, dysphonia, oral thrush (candidiasis).

- Spacer or valve holding chamber with non-breath-activated MDIs and mouthwashing and splattering after inhalation decrease local side effects.

- A number of the ICSs, including fluticasone, budesonide, and mometasone, are metabolized in the gastrointestinal tract and liver by CYP 3A4 isoenzymes. Potent inhibitors of CYP 3A4, such as ritonavir and ketaconazole, have the potential for increasing systemic concentrations of these ICSs by increasing oral availability and decreasing systemic clearance. Some cases of clinically significant Cushing syndrome and secondary adrenal insufficiency have been reported.

- In high doses, systemic effects may occur, although studies are not conclusive, and clinical significance of these effects has not been established (eg, adrenal suppression, osteoporosis, skin thinning, and easy bruising). In low-to-medium doses, suppression of growth velocity has been observed in children, but this effect may be transient, and the clinical significance has not been established.

**FIG 18.** Estimated comparative daily dosages for ICSs.
<table>
<thead>
<tr>
<th>Medication</th>
<th>&lt;6 Years of age</th>
<th>5-11 Years of age</th>
<th>&gt;12 Years of age and adult</th>
<th>Potential adverse effects</th>
<th>Comments (not all inclusive)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inhaled SABAs</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Medication</td>
<td>Dose applies to</td>
<td>Dose applies to</td>
<td>Dose applies to</td>
<td>(Applies to all 4 SABAs)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>abutent</td>
<td>abutent and</td>
<td>abutent</td>
<td></td>
</tr>
<tr>
<td>MDI</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Albuterol CFC</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>50 mg/mg/250</td>
<td>1-2 puffs in 5 minutes before exercise or every 4-6 hours as needed for symptoms</td>
<td>2 puffs in 5 minutes before exercise or every 4-6 hours as needed for symptoms</td>
<td>2 puffs in 5 minutes before exercise or every 4-6 hours as needed for symptoms</td>
<td>Tachycardia, skeletal muscle tremor, hypokalemia, increased lactic acid, headache, hypoglycemia, limbic, numbness and paresthesias, especially the elderly, may have adverse cardiovascular reactions with inhaled therapy.</td>
<td></td>
</tr>
<tr>
<td>HFA</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>40 mg/mg/200</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Levosalbuterol (HFA)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>40 mg/mg/200</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Metaproterenol CFC</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>200 mg/mg/400</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*CFC: Chlorofluorocarbon; HFA: hydrofluoroketone; M, intramuscular; NA, not available (not approved, no data available, or safety and efficacy not established for this age group).*
— If adherence and environment control measures are adequate, then step up 1 step (if not well controlled) or 2 steps (if very poorly controlled).
— If an alternative treatment was used initially, discontinue its use and use the preferred treatment option before stepping up therapy.
— A short course of oral systemic corticosteroids may be considered to gain more rapid control for patients whose asthma frequently interrupts sleep or normal daily activities or who are experiencing an exacerbation at the time of assessment.
— If lack of control persists, consider alternative diagnoses before stepping up further.
— If the patient experiences side effects, consider different treatment options.

To maintain control of asthma, regular follow-up contact is essential because asthma often varies over time.

- Schedule patient contact at 1-month to 6-month intervals; the interval will depend on such factors as the level or duration of asthma control and the level of treatment required.
- Consider a step down in therapy once asthma is well controlled for at least 3 months. A step down is necessary to identify the minimum therapy required to maintain good control. A reduction in therapy should be gradual and must be closely monitored. Studies are limited in guiding therapy reduction. In general, the dose of ICS may be reduced 25% to 50% every 3 months to the lowest possible dose.
- Consider seasonal periods of daily long-term control therapy for patients who have asthma symptoms only in relation to certain seasons (eg, seasonal pollens, allergens, or viral respiratory infections) and who have intermittent asthma the rest of the year. This approach has not been rigorously evaluated; close monitoring for 2 to 6 weeks after therapy is discontinued is essential to assure sustained asthma control.

### Stepwise treatment recommendations for different ages

Recommendations for treatments in the different steps are presented in 3 age groups (0-4 years, 5-11 years, and ≥12 years and older) because the course of the disease may change over time, the relevance of measures of impairment or risk and the potential short-term and long-term impact of medications may be age-related, and varied levels of scientific evidence are available for the different ages.

#### Steps for children 0 to 4 years of age

See Fig 13 for recommended treatments in the different steps and Figs 17 to 19 for recommended medication dosages. In addition to the general principles of the stepwise approach, special considerations for this age group include initiating therapy, selecting among treatment options, and monitoring response to therapy.

The initiation of daily long-term control therapy in children ages 0 to 4 years is recommended as follows:

<table>
<thead>
<tr>
<th>Medication</th>
<th>Dosages apply to first 3 corticosteroids</th>
<th>(Apply to the first 3 corticosteroids)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Systemic corticosteroids</strong></td>
<td><strong>Short course burst: 1-2 mg/kg/d, maximum 60 mg/d, for 3-10 days</strong></td>
<td><strong>Short-term i.v.</strong></td>
</tr>
<tr>
<td>Methylprednisolone</td>
<td><strong>Short course burst: 40-60 mg/d as single or 2 divided doses for 3-10 days</strong></td>
<td><strong>Note: Susceptibility to adverse effects may differ with different corticosteroids.</strong></td>
</tr>
<tr>
<td>Prednisolone</td>
<td><strong>Prednisone</strong></td>
<td><strong>The burst should be continued until patient achieves 80% PEF</strong></td>
</tr>
<tr>
<td>5-mg tablets</td>
<td></td>
<td><strong>Other systemic corticosteroids such as hydrocortisone and dexamethasone given in equivalent daily doses are likely to be as effective as prednisolone.</strong></td>
</tr>
<tr>
<td>1, 2, 5, 10, 20, 50-mg tablets, 5 mg/cc</td>
<td><strong>Prednisone</strong></td>
<td><strong>Consideration should be given to existing conditions that could be worsened by systemic corticosteroids, such as herpes virus infections, varicella, tuberculosis, hypertension, peptic ulcer, diabetes mellitus, osteoporosis, and Strongyloides.</strong></td>
</tr>
<tr>
<td><strong>Prednisolone acetate</strong></td>
<td><strong>Repository injection</strong></td>
<td><strong>Consideration</strong></td>
</tr>
<tr>
<td>40 mg/mL 60 mg/mL</td>
<td><strong>If necessary</strong></td>
<td><strong>(Methylprednisolone)</strong>*</td>
</tr>
</tbody>
</table>

**FIG 19. Continued.**
It is recommended for reducing impairment and risk of exacerbations in infants and young children who had 4 or more episodes of wheezing in the past year that lasted more than 1 day and affected sleep AND who have a positive asthma predictive index (either 1 of the following: a parental history of asthma, a physician’s diagnosis of atopic dermatitis, or evidence of sensitization to aeroallergens; OR 2 of the following: evidence of sensitization to foods, >4 percent peripheral blood eosinophilia, or wheezing apart from colds).

- It should be considered for reducing impairment in infants and young children who consistently require symptomatic treatment >2 days per week for a period of more than 4 weeks.
- It should be considered for reducing risk in infants and young children who have 2 exacerbations requiring systemic corticosteroids within 6 months.
- It may be considered for use only during periods, or seasons, of previously documented risk (eg, during seasons of viral respiratory infections).

The decision about when to start long-term daily therapy is difficult. The chronic airway inflammatory response in asthma can develop in the preschool years; for example, between 50% and 80% of children who have asthma developed symptoms before their fifth birthday. Adequate treatment will reduce the burden of illness, and underdiagnosis and undertreatment are key problems in this age group. Not all wheeze and cough are caused by asthma, however, and caution is needed to avoid giving inappropriate, prolonged therapy.

Initiating long-term control therapy will depend on consideration of issues regarding diagnosis and prognosis.

- Viral respiratory infections are the most common cause of asthma symptoms in this age group, and many children who wheeze with respiratory infections respond well to asthma therapy even though the diagnosis of asthma is not clearly established. For children who have exacerbations with viral infections, exacerbations are often severe (requiring emergency care or hospitalization), yet the child has no significant symptoms in between these exacerbations. These children have a low level of impairment but a high level of risk.

- Most young children who wheeze with viral respiratory infection experience a remission of symptoms by 6 years of age, perhaps due to growing airway size.

- However, two-thirds of children who have frequent wheezing AND also have a positive asthma predictive index (see above) are likely to have asthma throughout childhood. Early identification of these children allows appropriate treatment with environmental control measures and medication to reduce morbidity.

Select medications with the following considerations for young children:

- Asthma treatment for young children, especially infants, has not been studied adequately. Most recommendations are based on limited data and extrapolations from studies in older children and adults. Preferred treatment options are based on individual drug efficacy studies in this age group; comparator trials are not available.

- The following long-term control medications are FDA-approved for the following ages in young children: ICS budesonide nebulizer solution (1-8 years of age); ICS fluticasone dry powder inhaler (>4 years of age); LABA salmeterol dry powder inhaler, alone or in combination with ICS (>4 years of age); LTRA montelukast (chewable tablets, 2-6 years of age; granules, down to 1 year old).

- Several delivery devices are available, and the doses received may vary considerably among devices and age groups. In general, children <4 years of age will have less difficulty with a face mask and either (1) a nebulizer or (2) an MDI with a VHC (Fig 10).

- Inhaled corticosteroids are the preferred long-term control medication for initiating therapy. The benefits of ICSs outweigh any concerns about potential risks of a small, nonprogressive reduction in growth velocity or other possible adverse effects. ICSs, as with all medications, should be titrated to as low a dose as needed to maintain control.

- For children whose asthma is not well controlled on low-dose ICS, few studies are available on step-up therapy in this age group, and the studies have mixed findings. Some data on children ≤4 years old and younger show dose-dependent improvements in the domains of impairment and risk of exacerbation from taking ICS. Data from studies on LABA combined with ICS have only small numbers of 4-year-old children, and these data show improvement in the impairment but not risk domain. Adding a noncorticosteroid long-term control medication to medium-dose ICS may be considered before increasing the dose of ICS to high-dose to avoid potential risk of side effects with high doses of medication.

Monitor response to therapy closely, because treatment of young children is often in the form of a therapeutic trial.

- If a clear and beneficial response is not obvious within 4 to 6 weeks and the patient’s/family’s medication technique and adherence are satisfactory, treatment should be stopped. Alternative therapies or alternative diagnoses should be considered.

- If a clear and beneficial response is sustained for at least 3 months, consider a step down to evaluate the need for continued daily long-term control therapy. Children in this age group have high rates of spontaneous remission of symptoms.
Steps for children 5 to 11 years of age

See Fig 13 for recommended treatments in different steps and Figs 17 to 19 for recommended medication dosages. Special considerations for this age group include the following:

Promote active participation in physical activities, exercise, and sports because physical activity is an essential part of a child’s life. Treatment immediately before vigorous activity usually prevents EIB (see “EIB”). However, if the child has poor endurance or has symptoms during usual play activities, a step up in therapy is warranted.

Directly involve children ≥10 years of age (and younger children as appropriate) in developing their written asthma action plans and reviewing their adherence. This involvement may help address developmental issues of emerging independence by building the children’s confidence, increasing personal responsibility, and gaining problem-solving skills.

Encourage parents to take a copy of the written asthma action plan to the student’s school, or child care or extended care setting, or camp.

Consider the following when selecting treatment options:

- Inhaled corticosteroids are the preferred long-term control therapy. The benefits of ICSs outweigh any concerns about potential risks of a small, nonprogressive reduction in growth velocity or other possible adverse effects. ICSs, as with all medications, should be titrated to as low a dose as needed to maintain control. High-quality evidence demonstrates the effectiveness of ICS in children 5 to 11 years of age, and comparator studies demonstrate improved control with ICS on a range of asthma outcomes compared to other long-term control medications.

- Step-up treatment options for children whose asthma is not well controlled on low-dose ICS have not been adequately studied or compared in this age group. The selection will depend on the domain of particular relevance (impairment, risk, or both) and clinician-patient preference.

  — For the impairment domain:
    - Children who have low lung function and ≥2 days per week of impairment may be better served by adding a LABA to a low dose of ICS (on the basis of studies in older children and adults).
    - Increasing the dose of ICS to medium-dose can improve symptoms and lung function in those children who have greater levels of impairment (on the basis of studies in children).
    - One study in children suggests some benefit in the impairment domain with adding LTRA.

  — For the risk domain:
    - Studies have not demonstrated that adding LABA or LTRA reduces exacerbations in children. Adding LABA has the potential risk of rare life-threatening or fatal exacerbations.

Monitor asthma progression. Declines in lung function or repeated periods of worsening asthma impairment may indicate a progressive worsening of the underlying severity of asthma. Although there is no indication that treatment alters the progression of the underlying disease in children, adjustments in treatment may be necessary to maintain asthma control.
Steps for youths ≥ 12 years of age and adults

See Fig 16 for recommended treatment options in different steps and Figs 18 and 19 for recommended medication dosages for youths ≥ 12 years of age and adults.

Special considerations for this age group include the following:

For youths:

- Involve adolescents in the development of their written asthma action plans and reviewing their adherence.
- Encourage students to take a copy of their plan to school, after-school programs, and camp.
- Encourage adolescents to be physically active.

For older adults:

- Consider a short course of oral systemic corticosteroids to establish reversibility and the extent of possible benefit from asthma treatment. Chronic bronchitis and emphysema may coexist with asthma.
- Adjust medications as necessary to address coexisting medical conditions. For example, consider calcium and vitamin D supplements for patients who take ICS and have risk factors for osteoporosis. Consider increased sensitivity to side effects of bronchodilators, especially tremor and tachycardia with increasing age, and increased possibilities for drug interactions with theophylline. Consider also that nonsteroidal anti-inflammatory drugs prescribed for arthritis and the β-blockers prescribed for hypertension or glaucoma may exacerbate asthma.
- Review the patient’s technique and adherence in using medications, and make necessary adjustments. Physical or cognitive impairments may make proper technique difficult.

Consider the following when selecting treatment options:

- Recommended treatment for step 3 weighs the high-quality evidence demonstrating the benefits of adding LABA to low-dose ICS against the potential risk of rare life-threatening or fatal exacerbations with the use of LABA. The selection will depend on the domain of particular relevance (impairment, risk, or both) and clinician-patient preference.
  - Adding LABA more consistently results in improvements in the impairment domain compared with increasing the dose of ICS.
  - If the risk domain is of particular concern, then a balance of potential risks needs to be considered.
- Adding LABA to low-dose ICS reduces the frequency of exacerbations to a greater extent than doubling the dose of ICS, but adding LABA has the potential risk of rare life-threatening or fatal exacerbations.
- Increasing the dose of ICS can significantly reduce the risk of exacerbations, but this benefit may require as much as a 4-fold increase in the ICS dose. This dose may increase the potential risk of systemic effects, although the risk is small within the medium-dose range.
- Comparator studies demonstrate significantly greater improvements with adding LABA to ICS compared with other adjunctive therapies.
- Clinicians who administer omalizumab are advised to be prepared and equipped for the identification and treatment of anaphylaxis that may occur, to observe patients for an appropriate period after each omalizumab injection (the optimal length of the observation is not established), and to educate patients about the risks of anaphylaxis and how to recognize and treat it if it occurs (eg, using prescription auto injectors for emergency self-treatment, and seeking immediate medical care).

Managing special situations

Patients who have asthma may encounter situations that will require adjustments to their asthma management to keep their asthma under control, such as EIB, pregnancy, and surgery.

EIB

Exercise-induced bronchospasm should be anticipated in all patients with asthma. A history of cough, shortness of breath, chest pain or tightness, wheezing, or endurance problems during exercises suggests EIB.

An exercise challenge in which a 15% decrease in PEF or FEV1 occurs (measured before and after exercise at 5-minute intervals for 20-30 minutes) will establish the diagnosis.

An important dimension of adequate asthma control is a patient’s ability to participate in any activity he or she chooses without experiencing asthma symptoms. EIB should not limit either participation or success in vigorous activities.

Recommended treatments for EIB include the following:

- Long-term control therapy, if appropriate. Frequent or severe EIB may indicate the need to initiate or step up long-term control medications.
- Pretreatment before exercise:
  - Inhaled β2-agonists will prevent EIB for more than 80% of patients. SABA used shortly before exercise may be helpful for 2 to 3 hours. LABA can be protective as long as 12 hours, but there is some shortening of the duration of protection when LABA is used on a daily basis. Frequent or chronic use of LABA as pretreatment for EIB is discouraged, because it may disguise poorly controlled persistent asthma.
  - Leukotriene receptor antagonists, with an onset of action generally hours after administration, can attenuate EIB in as many as 50% of patients.
— Cromolyn or nedocromil taken shortly before exercise is an alternative treatment, but it is not as effective as SABAs.
— A warm-up period before exercise may reduce the degree of EIB.
— A mask or scarf over the mouth may attenuate cold-induced EIB.

**Pregnancy**

Maintaining asthma control during pregnancy is important for the health and well being of both the mother and her baby. Maintaining lung function is important to ensure oxygen supply to the fetus. Uncontrolled asthma increases the risk of perinatal mortality, pre-eclampsia, preterm birth, and low-birth-weight infants. It is safer for pregnant women to be treated with asthma medications than to have asthma symptoms and exacerbations.

- **Monitor the level of asthma control and lung function during prenatal visits.** The course of asthma improves in 1/3 of women and worsens for 1/3 of women during pregnancy. Monthly evaluations of asthma will allow the opportunity to step up therapy if necessary and to step down therapy if possible.
- **Albuterol is the preferred SABA.** The most data related to safety during human pregnancy are available for albuterol.
- **Inhaled corticosteroids are the preferred long-term control medication.** Budesonide is the preferred ICS because more data are available on using budesonide in pregnant women than are available on other ICSs, and the data are reassuring. However, no data indicate that the other ICS preparations are unsafe during pregnancy.

**Surgery**

Patients who have asthma are at risk for complications during and after surgery. These complications include acute bronchoconstriction triggered by intubation, hypoxemia and possible hypercapnia, impaired effectiveness of cough, atelectasis, and respiratory infection, and, if a history of sensitivity is present, reactions to latex exposure or some anesthetic agents.

The following actions are recommended to reduce the risk of complications during surgery:

- **Before surgery,** review the level of asthma control, medication use (especially oral systemic corticosteroids within the past 6 months), and pulmonary function.
- **Provide medications before surgery** to improve lung function if lung function is not well controlled. A short course of oral systemic corticosteroids may be necessary.
- **For patients receiving oral systemic corticosteroids** during the 6 months before surgery and for selected patients on long-term high-dose ICS, give 100 mg hydrocortisone every 8 hours intravenously during the surgical period, and reduce the dose rapidly within 24 hours after surgery.

**Disparities**

Multiple factors contribute to the higher rates of poorly controlled asthma and asthma deaths among blacks and Latinos patients compared with whites patients. These factors include socioeconomic disparities in access to quality medical care, underprescription and underutilization of long-term control medication, cultural beliefs and practices about asthma management, and perhaps biological and pathophysiological differences that affect the underlying severity of asthma and response to treatment. **Heightening awareness of disparities and cultural barriers, improving access to quality care, and improving communication strategies between clinicians and ethnic or racial minority patients regarding use of asthma medications may improve asthma outcomes.**
MANAGING EXACERBATIONS

Asthma exacerbations are acute or subacute episodes of progressively worsening shortness of breath, cough, wheezing, and chest tightness, or some combination of these symptoms. Exacerbations are characterized by decreases in expiratory airflow; objective measures of lung function (spirometry or PEF) are more reliable indicators of severity than symptoms are. Individuals whose asthma is well controlled with ICSs have decreased risk of exacerbations. However, these patients can still be vulnerable to exacerbations—for example, when they have viral respiratory infections.

Effective management of exacerbations incorporates the same 4 components of asthma management used in managing asthma long-term: assessment and monitoring, patient education, environmental control, and medications.

Classifying severity

Do not underestimate the severity of an exacerbation. Severe exacerbations can be life-threatening and can occur in patients at any level of asthma severity—intermittent, or mild, moderate, or severe persistent asthma (Fig 20).

Patients at high risk of asthma-related death require special attention—particularly intensive education, monitoring, and care. Such patients should be advised to seek medical care early during an exacerbation. Risk factors for asthma-related death include the following:

- Previous severe exacerbation (eg, intubation or intensive care unit admission for asthma)
- Two or more hospitalizations or >3 ED visits in the past year
- Use of >2 canisters of SABA per month
- Difficulty perceiving airway obstruction or the severity of worsening asthma
- Low socioeconomic status or inner-city residence
- Illicit drug use
- Major psychosocial problems or psychiatric disease
- Comorbidities, such as cardiovascular disease or other chronic lung disease

Home management

Early treatment by the patient at home is the best strategy for managing asthma exacerbations. Patients should be instructed how to do the following:

- Use a written asthma action plan that notes when and how to treat signs of an exacerbation. A peak flow–based plan may be particularly useful for patients who have difficulty perceiving airflow obstruction or have a history of severe exacerbations.
- Recognize early indicators of an exacerbation, including worsening PEF.
- Adjust their medications by increasing SABA and, in some cases, adding a short course of oral systemic corticosteroids. Doubling the dose of ICSs is not effective.

- Remove or withdraw from allergens or irritants in the environment that may contribute to the exacerbation.
- Monitor response to treatment and promptly communicate with the clinician about any serious deterioration in symptoms or PEF or about decreased responsiveness to SABA treatment, including decreased duration of effect.

The following home management techniques are not recommended because no studies demonstrate their effectiveness and they may delay patients from obtaining necessary care: drinking large volumes of liquids; breathing warm, moist air; or using over-the-counter products, such as antihistamines or cold remedies. Pursed-lip and other forms of breathing may help to maintain calm, but these methods do not improve lung function.

Management in the urgent or emergency care and hospital settings

Emergency medical services providers should have prehospital protocols that allow administration of SABA, supplemental oxygen, and (with appropriate medical oversight) anticholinergics and oral systemic corticosteroids to patients who have signs or symptoms of an asthma exacerbation.

Treatment strategies for managing moderate or severe exacerbations in the urgent or emergency care setting are described here. See Fig 21 for a detailed sequence of recommended actions for monitoring and treatment and Fig 22 for dosages of drugs for asthma exacerbations.

- Administer supplemental oxygen to correct significant hypoxemia in moderate or severe exacerbations.
- Administer repetitive or continuous administration of SABA to reverse airflow obstruction rapidly.
- Administer oral systemic corticosteroids to decrease airway inflammation in moderate or severe exacerbations or for patients who fail to respond promptly and completely to SABA treatment.
- Monitor response to therapy with serial assessments.
  - For children:
    - No single measure is best for assessing severity or predicting hospital admission.
    - Lung function measures (FEV₁ or PEF) may be useful for children ≥5 years of age, but these measures may not be obtainable during an exacerbation.
    - Pulse oximetry may be useful for assessing the initial severity; a repeated measure of pulse oximetry of <92% to 94% after 1 hour is predictive of the need for hospitalization.
    - Signs and symptoms scores may be helpful. Children who have signs and symptoms after

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1 to 2 hours of initial treatment and who continue to meet the criteria for a moderate or severe exacerbation have a >84% chance of requiring hospitalization.

— For adults:
- Repeated lung function measures (FEV₁ or PEF) at 1 hour and beyond are the strongest single predictor of hospitalization. Such measures may not be helpful, or easily obtained, during severe exacerbations.
- Pulse oximetry is indicated for patients who are in severe distress, have FEV₁ or PEF <40% predicted, or are unable to perform lung function measures. Only repeat assessments after initial treatment, not a single assessment on admission, are useful for predicting the need for hospitalization.
- Signs and symptoms scores at 1 hour after initial treatments improve the ability to predict need for hospitalization. The presence of drowsiness is a useful predictor of impending respiratory failure and is reason to consider immediate transfer to a facility equipped to offer ventilatory support.
- Consider adjunctive treatments, such as intravenous magnesium sulfate or heliox, in severe exacerbations, if patients are unresponsive to the initial treatments listed (eg, FEV₁ or PEF <40% predicted or personal best after initial treatments).

- Provide the following to prevent relapse of the exacerbation and recurrence of another exacerbation:
  — Referral to follow-up asthma care within 1 to 4 weeks. In addition, encourage the patient to contact (eg, by telephone) his or her asthma care provider during the first 3 to 5 days after discharge. A follow-up visit is essential to review the patient’s written asthma action plan, adherence, and environmental control and to consider a step up in therapy. If appropriate, consider referral to an asthma self-management education program.
  — An ED asthma discharge plan (Fig 23).
  — Review of inhaler technique whenever possible.
  — Consideration of initiating ICS.

- Treatments that are not recommended in the emergency care or hospital setting include the following: methylxanthines, antibiotics (except as needed for comorbid conditions), aggressive hydration, chest physical therapy, mucolytics, or sedation. Inhaled ipratropium bromide is a helpful adjunctive therapy in the emergency care setting, but it does not provide additional benefit after a patient is hospitalized for a severe exacerbation.
<table>
<thead>
<tr>
<th>Medication</th>
<th>Child dose*</th>
<th>Adult dose</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Inhaled SABAs</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Albuterol</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nebulizer solution (0.63 mg/mL, 1.25 mg/mL)</td>
<td>0.15 mg/kg (minimum dose 2.5 mg) every 20 minutes for 3 doses then 6-15.3 mg/kg up to 10 mg every 1-4 hours as needed, or 0.5 mg/kg/h by continuous nebulization.</td>
<td>2.5-5 mg every 20 minutes for 3 doses, then 2.5-10 mg every 1-4 hours as needed, or 10-15 mg/h continuously.</td>
<td>Only selective β₂-agonists are recommended. For optimal delivery, dilute aerosol to minimum of 3 mL at gas flow of 6-8 L/min. Use large volume nebulizers for continuous administration. May mix with ipratropium nebulizer solution.</td>
</tr>
<tr>
<td>MDI (99 mg/puff)</td>
<td>4-6 puffs every 20 minutes for 3 doses, then every 1-4 hours inhalation maneuver as needed. Use VHC, add mask in children &lt;4 years.</td>
<td>4-6 puffs every 20 minutes up to 4 hours, then every 1-4 hours as needed.</td>
<td>In mild-to-moderate exacerbations, MDI plus VHC is as effective as nebulized therapy with appropriate administration technique and coaching by trained personnel.</td>
</tr>
<tr>
<td>Bolovent</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nebulizer solution (2 mg/mL)</td>
<td>See albuterol dose; thought to be half as potent as albuterol on mg basis.</td>
<td>See albuterol dose.</td>
<td>Has not been studied in severe asthma exacerbations. Do not mix with other drugs.</td>
</tr>
<tr>
<td>MDI (370 mcg/puff)</td>
<td>See albuterol MDI dose.</td>
<td>See albuterol MDI dose.</td>
<td>Has not been studied in severe asthma exacerbations.</td>
</tr>
<tr>
<td><strong>Levalbuterol (R-albuterol)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nebulizer solution (0.63 mg/mL, 1.25 mg/mL)</td>
<td>0.075 mg/kg (minimum dose 1.25 mg) every 20 minutes for 3 doses, then 0.075-0.15 mg/kg up to 5 mg every 1-4 hours as needed.</td>
<td>1.25-2.5 mg every 20 minutes for 3 doses, then 1.25-5 mg every 1-4 hours as needed.</td>
<td>Levalbuterol administered in 1/2 the milligram dose of albuterol provides comparable efficacy and safety. Has not been evaluated by continuous nebulization.</td>
</tr>
<tr>
<td>MDI (45 mcg/puff)</td>
<td>See albuterol MDI dose.</td>
<td>See albuterol MDI dose.</td>
<td>Has not been studied in severe asthma exacerbations.</td>
</tr>
<tr>
<td><strong>Pirbuterol</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MDI (200 mcg/puff)</td>
<td>See albuterol MDI dose; thought to be half as potent as albuterol on a mg basis.</td>
<td>See albuterol MDI dose.</td>
<td>Has not been studied in severe asthma exacerbations.</td>
</tr>
<tr>
<td><strong>Systemic (inhaled) β₂-agonists</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Epinephrine 1:1000 (1 mg/mL)</td>
<td>0.01 mg/kg up to 0.3-0.5 mg every 20 minutes for 3 doses sq.</td>
<td>0.3-0.5 mg every 20 minutes for 3 doses sq.</td>
<td>No proven advantage of systemic therapy over aerosol.</td>
</tr>
<tr>
<td>Terbutaline (1 mg/mL)</td>
<td>0.01 mg/kg every 20 minutes for 3 doses every 4-6 hours as needed sq.</td>
<td>0.25 mg every 20 minutes for 3 doses sq.</td>
<td>No proven advantage of systemic therapy over aerosol.</td>
</tr>
</tbody>
</table>

**FIG 22.** Dosages of drugs for asthma exacerbations.† sq, Subcutaneous.
<table>
<thead>
<tr>
<th>Medication</th>
<th>Child dose*</th>
<th>Adult dose</th>
<th>Comments (not all inclusive)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Anticholinergics</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ipratropium bromide</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nebulizer solution (0.25 mg/mL)</td>
<td>0.25–0.5 mg every 20 minutes for 3 doses, then as needed</td>
<td>0.5 mg every 20 minutes for 3 doses, then as needed</td>
<td>May mix in same nebulizer with albuterol. Should not be used as first-line therapy; should be added to SABA therapy for severe exacerbations. The addition of ipratropium has not been shown to provide further benefit once the patient is hospitalized.</td>
</tr>
<tr>
<td>MDI (10 mcg/puff)</td>
<td>4–6 puffs every 20 minutes as needed up to 3 hours</td>
<td>8 puffs every 20 minutes as needed up to 3 hours</td>
<td>Should use with HVC and face mask for children &lt;4 years.</td>
</tr>
<tr>
<td>Ipratropium with albuterol</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nebulizer solution (each 3 mL vial contains 6.5 mg ipratropium bromide and 2.5 mg albuterol)</td>
<td>1.5 mL every 20 minutes for 3 doses, then as needed</td>
<td>3 mL every 20 minutes for 3 doses, then as needed</td>
<td>May be used for up to 3 hours in the initial management of severe exacerbations. The addition of ipratropium to albuterol has not been shown to provide further benefit once the patient is hospitalized.</td>
</tr>
<tr>
<td>MDI (Each puff contains 18 mcg ipratropium bromide and 90 mcg albuterol)</td>
<td>4–6 puffs every 20 minutes as needed up to 3 hours</td>
<td>8 puffs every 20 minutes as needed up to 3 hours</td>
<td>Should use with HVC and face mask for children &lt;4 years.</td>
</tr>
<tr>
<td><strong>Systemic corticosteroids</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prednisone</td>
<td>1 mg/kg in 2 divided doses (maximum = 60 mg/d) until PEF is 70% of predicted or personal best</td>
<td>40–80 mg/day in 1 or 2 divided doses until PEF reaches 70% of predicted or personal best</td>
<td>(Apply to all 3 corticosteroids.) For outpatient burst, use 40–80 mg in single or 2 divided doses for total of 5–10 days in adults (children: 1–2 mg/kg maximum 60 mg/d for 3–10 days).</td>
</tr>
<tr>
<td>Methylprednisolone</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prednisolone</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Children ≥12 years of age.

**Notes:**
- There is no known advantage for higher doses of corticosteroids in severe asthma exacerbations, nor is there any advantage for intravenous administration over oral therapy provided gastrointestinal transit time or absorption is not impaired.
- The total course of systemic corticosteroids for an asthma exacerbation requiring an ED visit of hospitalization may last from 3 to 10 days. For corticosteroid courses of less than 1 week, there is no need to taper the dose. For slightly longer courses (eg, as long as 10 days), there probably is no need to taper, especially if patients are concurrently taking ICSs.
- ICSs can be started at any point in the treatment of an asthma exacerbation.

**FIG 22. Continued.**
### A. EMERGENCY DEPARTMENT—ASTHMA DISCHARGE PLAN

**Name:** was seen by Dr. on __/__/ __

- Take your prescribed medications as directed—do not delay!
- Asthma attacks like this one can be prevented with a long-term treatment plan
- Even when you feel well, you may need daily medicine to keep your asthma in good control and prevent attacks.
- Visit your doctor or other health care provider as soon as you can to discuss how to control your asthma and to develop your own action plan.

Your follow-up appointment with ___________ is on __/__/ __. Tel: ___________.

#### YOUR MEDICINE FOR THIS ASTHMA ATTACK IS:

<table>
<thead>
<tr>
<th>Medication</th>
<th>Amount</th>
<th>Doses per day, for # days</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prednisone/prednisolone (oral corticosteroids)</td>
<td>a day for _____ days</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Take the entire prescription, even when you start to feel better.</td>
</tr>
<tr>
<td>Inhaled albuterol</td>
<td>_____ puffs every 4 to 6 hours if you have symptoms, for _____ days</td>
<td></td>
</tr>
</tbody>
</table>

#### YOUR DAILY MEDICINE FOR LONG-TERM CONTROL AND PREVENTING ATTACKS IS:

<table>
<thead>
<tr>
<th>Medication</th>
<th>Amount</th>
<th>Doses per day</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inhaled corticosteroids</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### YOUR QUICK-RELIEF MEDICINE WHEN YOU HAVE SYMPTOMS IS:

<table>
<thead>
<tr>
<th>Medication</th>
<th>Amount</th>
<th>Number of doses/day</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inhaled albuterol</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### ASK YOURSELF 2 TO 3 TIMES PER DAY, EVERY DAY, FOR AT LEAST 1 WEEK:

* "How good is my asthma compared to when I left the hospital?"

<table>
<thead>
<tr>
<th>If you feel much better:</th>
<th>If you feel better, but still need your quick-relief inhaler often:</th>
<th>If you feel about the same:</th>
<th>If you feel worse:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Take your daily long-term control medicine.</td>
<td>Take your daily long-term control medicine. See your doctor as soon as possible.</td>
<td>Use your quick-relief inhaler. Take your daily long-term control medicine. See your doctor as soon as possible—don’t delay.</td>
<td>Use your quick-relief inhaler. Take your daily long-term control medicine. Immediately go to the emergency department or call 9-1-1.</td>
</tr>
</tbody>
</table>

#### YOUR ASThma IS UNDER CONTROL WHEN YOU:

- Can be active daily and sleep through the night.
- Need fewer than 4 doses of quick-relief medicine in a week.
- Are free of shortness of breath, wheeze, and cough.
- Achieve an acceptable "peak flow" (discuss with your health care provider).

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FIG 23. A, ED—asthma discharge plan. B, ED—asthma discharge plan: how to use your MDI.
B

Using an inhaler seems simple, but most patients do not use it the right way. When you use your inhaler the wrong way, less medicine gets to your lungs.

For the next few days, read these steps aloud as you do them or ask someone to read them to you. Ask your doctor, nurse, other health care provider, or pharmacist to check how well you are using your inhaler.

Use your inhaler in 1 of the 3 ways pictured below (A or B are best, but C can be used if you have trouble with A and B). (Your doctor may give you other types of inhalers.)

Steps for using your inhaler

<table>
<thead>
<tr>
<th>Getting ready</th>
<th>1. Take off the cap and shake the inhaler.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2. Breathe out all the way.</td>
</tr>
<tr>
<td></td>
<td>3. Hold your inhaler the way your doctor said (A, B, or C below).</td>
</tr>
<tr>
<td>Breathe in slowly</td>
<td>4. As you start breathing in slowly through your mouth, press down on the inhaler 1 time. (If you use a holding chamber, first press down on the inhaler. Within 5 seconds, begin to breathe in slowly.)</td>
</tr>
<tr>
<td>Hold your breath</td>
<td>5. Keep breathing in slowly, as deeply as you can.</td>
</tr>
<tr>
<td></td>
<td>6. Hold your breath as you count to 10 slowly, if you can.</td>
</tr>
<tr>
<td></td>
<td>7. For inhaled quick-relief medicine (short-acting β2-agonists), wait about 15-30 seconds between puffs. There is no need to wait between puffs for other medicines.</td>
</tr>
</tbody>
</table>

A Hold inhaler 1 to 2 inches in front of your mouth (about the width of 2 fingers).

B Use a spacer/holding chamber. These come in many shapes and can be useful to any patient.

C Put the inhaler in your mouth. Do not use for steroids.

Clean your inhaler as needed, and know when to replace your inhaler. For instructions, read the package insert or talk to your doctor, other health care provider, or pharmacist.

FIG 23. Continued.
FOR MORE INFORMATION

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NHLBI Health Information Center
PO Box 30105
Bethesda, MD 20824-0105
Phone: 301-592-8573
TTY: 240-629-3255
Fax: 301-592-8563
Website: http://www.nih.gov.