An overview of asthma management

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INTRODUCTION

The main goals of asthma management are to optimize control of asthma symptoms and reduce the risk of asthma exacerbations while minimizing medication adverse effects. It is expected that a person with well-controlled asthma should be able to participate in work, school, play, and sports without limitation due to breathing. The four essential components of asthma management are patient education, minimizing exposure to asthma triggers, monitoring for changes in symptoms or lung function, and pharmacologic therapy. This overview topic presents the goals and components of asthma management. It is applicable to both children and adults. The recommendations are based upon major published asthma guidelines [1-4].

The diagnosis of asthma and more detailed management issues are reviewed separately. These topics are divided by age and, for adults, severity of asthma symptoms (table 1). The management of asthma exacerbations is also covered separately.

Asthma diagnosis and evaluation:

- (See "Asthma in children younger than 12 years: Initial evaluation and diagnosis".)
- (See "Asthma in adolescents and adults: Evaluation and diagnosis".)
- (See "Diagnosis and management of asthma in older adults".)
- (See "Evaluation of severe asthma in adolescents and adults".)
- (See "Severe asthma phenotypes".)

Detailed discussions of nonpharmacologic asthma management:

- (See "Asthma education and self-management".)
- (See "Trigger control to enhance asthma management".)
- (See "Allergen avoidance in the treatment of asthma and allergic rhinitis".)
- (See "Peak expiratory flow monitoring in asthma" and "Pulmonary function testing in asthma".)

Therapeutic approaches:

- (See "Asthma in children younger than 12 years: Overview of initiating therapy and monitoring control".)
- (See "Asthma in children younger than 12 years: Quick-relief (rescue) treatment for acute symptoms".)
- (See "Asthma in children younger than 12 years: Management of persistent asthma with controller therapies".)
- (See "Initiating asthma therapy and monitoring in adolescents and adults".)
- (See "Ongoing monitoring and titration of asthma therapies in adolescents and adults".)
- (See "Treatment of severe asthma in adolescents and adults".)

Asthma exacerbations:

- (See "Acute asthma exacerbations in children younger than 12 years: Overview of home/office management and severity assessment".)
- (See "Acute asthma exacerbations in children younger than 12 years: Emergency department management".)
- (See "Acute asthma exacerbations in children younger than 12 years: Inpatient management".)
- (See "Acute severe asthma exacerbations in children younger than 12 years: Intensive care unit management".)
- (See "Acute severe asthma exacerbations in children younger than 12 years: Endotracheal intubation and mechanical ventilation".)
- (See "Acute exacerbations of asthma in adults: Home and office management".)
- (See "Acute exacerbations of asthma in adults: Emergency department and inpatient management".)
- (See "Airway management in acute severe asthma for emergency medicine and critical care".)
- (See "Invasive mechanical ventilation in adults with acute exacerbations of asthma".)

ADVICE RELATED TO COVID-19 PANDEMIC

The United States Centers for Disease Control and Prevention (CDC) have identified asthma as a risk factor for severe coronavirus disease 2019 (COVID-19; severe acute respiratory syndrome coronavirus 2 [SAR-CoV-2]) [5]. Several studies including patients with well-controlled asthma do not indicate increased risk in this population [6-14]. Other investigations, including a large meta-analysis of over 100,000 patients and a British nationwide cohort, report higher rates of various adverse outcomes, including hospitalization, intubation, prolonged mechanical ventilation, and death from COVID-19 in patients with asthma [7,14-17]. In the large British cohort of over 35 million adults and nearly 3 million children aged 12 to 17 years, those with mild and/or well-controlled asthma were not at increased risk of poor outcomes compared with those without asthma [14]. However, adults who required medium- to high-dose inhaled glucocorticoids carried an elevated risk of COVID-19 hospitalization and death. Similarly, adolescents who required systemic glucocorticoids for an exacerbation in the prior year were at increased risk of COVID-19 hospitalization.

Based on the CDC designation, patients with asthma may be prioritized for antiviral therapies if they develop COVID-19. Note that the antiviral tablets nirmatrelvir and ritonavir interact with the long-acting beta-agonist bronchodilator salmeterol, which should be held for the five days of oral antiviral therapy and three additional days thereafter. Alternative bronchodilator therapy may be needed during this time in some patients. (See "COVID-19: Management of adults with acute illness in the outpatient setting".)

We concur with expert groups that every effort should be made to avoid exposure to the SARS-CoV-2 virus and that all regular medications necessary to maintain asthma control, including inhaled glucocorticoids, long-acting bronchodilators, leukotriene modifiers, oral glucocorticoids, and biologic agents approved for asthma, should be **continued** during the COVID-19 pandemic [4,18-20]. Maintaining good asthma control helps minimize the risk of an asthma exacerbation.

There is no good evidence that inhaled glucocorticoids or the biologic agents used for asthma have an adverse effect on the course of COVID-19 [8,21]. Biologic agents for asthma are not considered "immunosuppressive" with respect to COVID-19 infection. In regards to inhaled glucocorticoids, there is even some evidence from open-label trials for faster recovery with high doses (budesonide 1600 mcg/day) [22,23]. (See "COVID-19: Management of adults with acute illness in the outpatient setting", section on 'Therapies of limited or uncertain benefit'.)

For those taking long-term oral glucocorticoids, abruptly stopping this medication can have serious consequences and has not been shown to reduce the risk of acquiring, or the severity of, COVID-19. Neither inhaled glucocorticoids nor prednisone are thought to have a clinically meaningful interaction with the combination antiviral therapy nirmatrelvir-ritonavir over its five-day treatment course, although exposure to other systemic glucocorticoids may be more significantly increased [24]. The usual guidelines for prompt initiation of systemic glucocorticoids for asthma exacerbations should be followed regardless of COVID-19 exposure, as delaying therapy can increase the risk of a life-threatening exacerbation [25]. For patients with COVID-19 infection, inhaled asthma medications should be given by inhaler rather than nebulizer when possible to avoid aerosolizing the virus and enhancing disease spread. When aerosolized medications are needed, they should be taken, whenever possible, in an area that is separated from others in the home.

Persons with asthma who are eligible should receive the COVID-19 vaccine. Although there may be a small decrease in antibody levels after COVID-19 vaccination in patients receiving asthma biologics compared with healthy controls without asthma [26], there is no evidence that this is a clinically meaningful effect. Oral glucocorticoids at a dose ≥20 mg/day of prednisone (or equivalent) in adults or adolescents may blunt the immune response to COVID-19 vaccination. In our opinion, it is desirable for patients requiring daily glucocorticoids for treatment of an acute asthma exacerbation to delay vaccination until the acute exacerbation has resolved and the dose of oral glucocorticoids can be reduced to the equivalent of prednisone 10 mg or less. If dose reduction is not possible due to severe persistent disease, vaccination should be given regardless of glucocorticoid dose. Patients requiring ongoing use of ≥20 mg of prednisone daily should receive the vaccine schedule suggested for immunocompromised individuals. (See "COVID-19: Vaccines", section on 'Indications and vaccine selection' and "COVID-19: Vaccines", section on 'Immunocompromised individuals'.)

Peak expiratory flow (PEF) monitoring and monitoring of the forced expiratory volume in the first second of exhalation (FEV_1) has the potential for aerosol generation during forced exhalation or coughing provoked by the maneuver [27,28]. While recommendations vary, it seems prudent to limit PEF and FEV_1 measurement to settings with sufficient ventilation (eg, 6 to 12 air exchanges per hour) and where staff is wearing personal protective equipment (PPE; gloves, gown, face mask, and shield) [27-30]. Alternatively, patients can perform PEF or FEV_1 measurements (using a hand-held digital spirometer) in isolation at home during telehealth visits or prior to coming to the office.

Additional information about COVID-19 is provided separately. (See "COVID-19: Clinical features" and "COVID-19: Management in hospitalized adults" and "COVID-19: Management in children"

and "Patient education: COVID-19 overview (The Basics)" and "Patient education: COVID-19 vaccines (The Basics)".)

GOALS OF ASTHMA TREATMENT

The goals of chronic asthma management may be divided into two domains: achieving good control of asthma-related symptoms and minimizing future risk (asthma exacerbations, suboptimal lung function, adverse effects of medication) [1,31]. The patient's personal goals should be incorporated into decision-making regarding asthma management.

- **Optimizing control of asthma symptoms** – Good control of asthma means reducing the intensity and frequency of asthma symptoms and maintaining normal or near normal activity levels. Specific goals for asthma control include:

  - Freedom from frequent or troublesome symptoms of asthma (cough, chest tightness, wheezing, or shortness of breath)
  - Few night-time awakenings (≤2 nights per month) due to asthma
  - Minimal need (≤2 days per week) for medication for acute relief of asthma symptoms
  - Optimized lung function
  - Maintenance of normal daily activities, including work or school attendance and participation in athletics and exercise
  - Satisfaction with asthma care on the part of patients and caregivers

- **Reducing future risk** – The concept of risk encompasses the various adverse outcomes associated with asthma and its treatment [1]. These include asthma exacerbations, suboptimal lung development (children), loss of lung function over time (adults) [32], and adverse effects from asthma medications. A history of ≥1 exacerbation(s) in the past year is an independent risk factor for future exacerbations, as are poor adherence to asthma medication, incorrect inhaler technique, low lung function, smoking (eg, tobacco, cannabis) or vaping, an elevated concentration of exhaled nitric oxide (fractional exhaled nitric oxide, FeNO), and blood eosinophilia [4].

  Specific goals for reducing risk include:

  - Prevention of recurrent exacerbations and need for emergency department or hospital care
  - Prevention of reduced lung growth in children and loss of lung function in adults (due to poor asthma control)
  - Optimization of pharmacotherapy with minimal or no adverse effects

PATIENT EDUCATION

A key component of optimizing asthma control is the engagement of patients as active partners in their asthma management [4]. A successful partnership depends on robust and ongoing asthma education; a well-informed and motivated patient can assume a large measure of control over his or her asthma care.

The effectiveness of direct one-on-one education by the primary clinician, in particular, is well supported by evidence [1]. Numerous additional resources are available for asthma education, such as asthma educators, pharmacists, respiratory therapists, organized programs in the community, and online sources (eg, Asthma and Allergy Foundation, American Academy of Allergy, Asthma & Immunology, American College of Allergy, Asthma & Immunology, American Lung Association, National Jewish Health). Patient education information from UpToDate is listed below. (See 'Information for patients' below.)

Patient education decreases asthma exacerbations and hospitalizations and improves daily function and patient satisfaction in many, but not all, studies [33-37]. Based on limited evidence, culturally-specific asthma education may improve asthma outcomes in patients with low medical literacy or nontraditional belief systems [38].

Components of asthma education and self-management — The important components of asthma education are described in detail separately and include responses to the following questions (see "Asthma education and self-management"):

- What is asthma and what are its symptoms?
- What are the asthma triggers for the individual patient and how can they be mitigated?
- Which medications should be used for quick relief of asthma symptoms, which are used for asthma control, and which can be used in both circumstances?
- What is the correct technique for each inhaler that the patient uses (table 2 and table 3 and table 4 and table 5 and table 6)?
- Are there barriers that prevent the patient from taking medications regularly? If so, what methods would help improve adherence?

Asthma action plan — A personalized "asthma action plan" is a written document that provides instructions for the patient to follow at home. Although supportive data are limited [1,4], many asthma specialists, including ourselves, believe that written asthma action plans are useful in clarifying the medication regimen, helping patients to identify declines in asthma control, and guiding treatment adjustments in response to changes in symptoms and home

measurement of peak expiratory flow (PEF) and/or forced expiratory volume in the first second of exhalation (FEV_1).

Symptom-based action plans are used for the majority of patients. Home monitoring of PEF and/or FEV_1 may provide added benefit when incorporated into the asthma action plan, particularly for patients with moderate to severe asthma, patients who are poor perceivers of asthma control, and during pregnancy. (See 'Home monitoring' below and "Peak expiratory flow monitoring in asthma".)

Several asthma action plan forms are available:

- National Asthma Education and Prevention Program (NAEPP) Asthma action plan (form 1)
- NAEPP Asthma action plan for children (form 2)
- American Academy of Allergy Asthma & Immunology - School based asthma management program
- Asthma Society of Canada
- Asthma UK
- National Asthma Council Australia

Instructions for the use of asthma action plans are presented separately. (See "Asthma education and self-management".)

Controlling asthma triggers — The identification and avoidance of asthma "triggers" is an important component of successful asthma management, and successful avoidance or remediation may reduce the patient's need for medication. Directed questions can help identify specific triggers (eg, allergens, fumes, cigarette smoke exposure) to asthma and to comorbid conditions (table 7). Similarly, children should be questioned about symptoms that occur in school [4]. (See "Trigger control to enhance asthma management" and "Allergen avoidance in the treatment of asthma and allergic rhinitis".)

Adults should be questioned about symptoms not only in the home, but also in the workplace, as asthma can be exacerbated by both irritant and allergen exposures in occupational settings. Patterns of symptoms that suggest occupational triggers are presented in the table (table 8) [1]. (See "Occupational asthma: Definitions, epidemiology, causes, and risk factors".)

Allergen-specific IgE blood testing or skin testing can be helpful to confirm a patient's suspicion of allergic sensitivity or to clarify allergen sensitization when symptoms leave a patient uncertain as to the association with specific exposures. Allergen-specific immunotherapy may be an adjunct to standard pharmacologic treatment in selected patients with allergic asthma as

described separately [2,4]. (See "Asthma in adolescents and adults: Evaluation and diagnosis", section on 'Tests for allergy' and "Subcutaneous immunotherapy (SCIT) for allergic rhinoconjunctivitis and asthma: Indications and efficacy", section on 'Allergic asthma'.)

For triggers that should not be avoided, such as physical exertion, or are difficult to avoid, such as upper respiratory tract illnesses, hormonal fluctuations, and extreme emotion, patients should be taught how to adjust their asthma management to mitigate potential exacerbation of their symptoms.

INITIAL ASSESSMENT

The initial assessment of asthma severity typically occurs around the time of diagnosis. (See "Asthma in children younger than 12 years: Initial evaluation and diagnosis" and "Asthma in adolescents and adults: Evaluation and diagnosis".)

Assessment of asthma severity can serve as a guide to the intensity of therapy needed to bring asthma under good control. Asthma severity is influenced by multiple factors, including airway hyperresponsiveness and predisposition to allergy ("atopy"), environmental factors (such as irritant, viral, and allergen exposures), and comorbidities (such as obesity or chronic rhinosinusitis), and so it can change over time. The criteria for asthma **severity** are most easily used to help categorize patients who are not yet taking medication for control of their asthma or who are taking only a short-acting bronchodilator for symptom relief. On the other hand, assessment of asthma **control** is applicable to all patients regardless of their medication use and should be assessed at every patient encounter. (See 'Adjusting controller medication' below.)

Good asthma control is the goal of asthma management and is achievable in the great majority of patients with asthma. By expert consensus, patients meeting the following criteria have good asthma control:

- Symptoms of asthma requiring quick-reliever medication no more than two days per week
- Night-time awakenings no more than two nights per month
- Lung function (PEF or FEV_1) within the normal range (or within 20 percent of the patient's personal best value)
- No more than one exacerbation in the past year requiring urgent care and/or oral glucocorticoids

Besides noting the frequency of symptoms and risk factors for exacerbations, evaluation should include assessment (and documentation) of lung function in all persons old enough to perform

testing [4]. If the patient has an exacerbation at the time of the initial evaluation, assessment of lung function should be repeated following resolution of the exacerbation.

The National Asthma Education and Prevention Program (NAEPP) and the Global Initiative for Asthma (GINA) base initial therapy on assessment of asthma symptoms (frequency and intensity), respiratory impairment, and risk of poor asthma outcomes [1,4], although the specific categories vary (for adults and adolescents (table 1); for children 4 to 11 years (table 9); for infants and toddlers (table 10)). NAEPP includes spirometric or peak flow values in determining asthma severity. In contrast, GINA does not use spirometric values to guide medication selection after the diagnosis of asthma is confirmed, except for a forced expiratory volume in one second (FEV_1) <60 percent of predicted, which is a risk factor for exacerbations.

Both asthma severity and asthma control are determined by considering the following factors (for adults and adolescents (table 11); for children 4 to 11 (table 12); for infants and toddlers (table 13)) [1,4]:

- Reported frequency and severity of daytime symptoms and nocturnal awakenings over the previous four weeks
- Number of exacerbations requiring oral glucocorticoids in the previous year
- Current level of lung function, if able to perform this testing (FEV_1 and FEV_1/forced vital capacity [FVC] values, or peak expiratory flow [PEF] if spirometry not available)

GINA defines the severity of a patient's asthma based upon the level of treatment required to control symptoms and exacerbations, assessed retrospectively, but incorporates symptom frequency and severity and risk of exacerbation in the approach to initiation of therapy [4]. Good asthma control is defined as having few or no asthma symptoms, normal lung function, and rare or no exacerbations, as described for intermittent asthma below. (See 'Intermittent' below.)

The use of these elements to determine severity in adults and adolescents over the age of 11 years is presented in the table (table 1). The classification of severity in children aged 4 to 11 years is similar to that in adults (table 9). Severity in children under the age of four years, however, is classified somewhat differently (table 10).

CATEGORIES OF ASTHMA SEVERITY

Utility of severity categorization before and after treatment — Initial categorization of asthma severity may be helpful in determining the appropriate starting therapy to achieve

asthma control. Recategorizing after treatment initiation has less relevance to most therapeutic decision-making, which is primarily guided by degree of asthma control. The categorization of severe asthma carries the most important clinical and therapeutic implications.

Determining severity — Asthma is categorized according to the most severe element. As an example, a patient with symptoms and lung function suggesting intermittent asthma but with two or more exacerbations per year requiring oral glucocorticoids is considered to have mild persistent asthma.

Rationale for intermittent versus mild persistent categories — The distinction between intermittent and mild persistent asthma is based upon the consensus opinion of experts. However, there are no known biologic differences or specific biomarkers to distinguish the two categories.

The original concept (that patients with mild disease should be described in two separate categories) was developed with the purpose of encouraging medical providers to treat the chronic airway inflammation of asthma with chronic antiinflammatory therapy (rather than bronchodilators alone), even at a stage when lung function might be within the normal range (as in mild persistent asthma).

Treatment recommendations from the Global Initiative for Asthma (GINA) have re-examined this understanding of asthma pathobiology and have encouraged the use of anti-inflammatory therapy in all patients with asthma, even those with intermittent asthma, arguing that chronic (mostly eosinophilic) inflammation is characteristic of all asthma, regardless of severity; persons with intermittent asthma may experience severe asthma attacks, including life-threatening ones, that can be prevented by anti-inflammatory treatment; and intermittent use of inhaled glucocorticoids, rather than daily administration, can suffice to treat the airway inflammation of intermittent asthma.

Intermittent — Intermittent asthma is characterized by the following features in adults and adolescents (table 1) [1]:

- Daytime asthma symptoms occurring two or fewer days per week
- Two or fewer nocturnal awakenings per month
- Use of short-acting beta-agonists (SABAs) to relieve symptoms two or fewer days per week
- No interference with normal activities between exacerbations
- FEV_1 measurements between exacerbations that are consistently within the normal range (ie, ≥80 percent of predicted)
- FEV_1/FVC ratio between exacerbations that is normal (based on age-adjusted values)
- One or no exacerbations requiring oral glucocorticoids per year

If any of the features of a patient's asthma is more severe than those listed here, the asthma should be categorized as persistent, with its severity based on the most severe element.

A person using a SABA to prevent exercise-induced asthmatic symptoms might fit into this category of intermittent asthma even if exercising more than twice per week. (See "Exercise-induced bronchoconstriction".)

Equivalent tables for classifying asthma in children 0 to 3 years and 4 to 11 years are provided (table 10 and table 9).

Mild persistent — Mild persistent asthma is characterized by the following (table 1):

- Symptoms more than twice weekly (although less than daily)
- Approximately three to four nocturnal awakenings per month due to asthma (but fewer than every week)
- Use of SABAs to relieve symptoms more than two days out of the week (but not daily)
- Minor interference with normal activities
- FEV_1 measurements between exacerbations that are within normal range (≥80 percent of predicted)
- Two or more exacerbations per year requiring oral glucocorticoids

Equivalent tables for asthma in children 0 to 3 years and 4 to 11 years are provided (table 10 and table 9). (See "Asthma in children younger than 12 years: Management of persistent asthma with controller therapies".)

Moderate persistent — The presence of any of the following features is considered an indication of moderate disease severity (table 1):

- Daily symptoms of asthma
- Nocturnal awakenings as often as once per week
- Daily need for reliever therapy for symptom relief
- Some limitation in normal activity
- FEV_1 ≥60 and <80 percent of predicted and FEV_1/FVC below normal

Equivalent figures for asthma in children 0 to 3 years and 4 to 11 years are provided (table 10 and table 9). (See "Asthma in children younger than 12 years: Management of persistent asthma with controller therapies".)

Severe persistent — Severe persistent asthma, as defined by the NAEPP, is manifest by the presence of asthma symptoms throughout the day, nocturnal awakening due to asthma nightly, reliever medication needed for symptoms several times/day, or extreme activity limitation due

to asthma [1,2]. Such patients need prompt initiation of asthma therapy. The response to therapy is difficult to predict at initial presentation. Intensive therapy should be begun, but some patients will achieve good asthma control long term with only low-to-medium doses of inhaled GC and no longer be considered to have severe asthma [1,4].

The definition of “severe asthma” has been the focus of many expert panels and research consortia. The European Respiratory Society/American Thoracic Society (ERS/ATS) guidelines define "severe" asthma as symptoms and lung function impairment that require high-dose inhaled GC and a second controller agent (such as an inhaled long-acting beta-agonist bronchodilator [LABA]) or near continuous oral glucocorticoid therapy to achieve asthma control or may not achieve control with this therapy (table 14) [4,39,40]. (See "Evaluation of severe asthma in adolescents and adults", section on 'Definition'.)

The World Health Organization has offered a definition of severe asthma that includes a useful subcategorization of patients [41]. Some patients have poor asthma control despite treatment with high-dose inhaled GC and a LABA because of confounding and potentially remediable factors, like poor medication adherence, allergen or irritant exposures in their home or work environment, or treatable comorbidities like rhinosinusitis. They are considered to have "difficult-to-treat" severe asthma. In contrast, other patients continue to have poor asthma control despite good medication adherence, modification of environmental exposures, and management of comorbidities. Such patients are considered to have "treatment-resistant" severe asthma and are likely candidates for biologic agents. (See "Enhancing patient adherence to asthma therapy" and "Treatment of severe asthma in adolescents and adults", section on 'Selecting among biologic agents'.)

Equivalent parameters for asthma in children 0 to 4 years and 5 to 11 years are provided (table 10 and table 9). (See "Asthma in children younger than 12 years: Management of persistent asthma with controller therapies".)

INITIATING PHARMACOLOGIC TREATMENT

Pharmacologic treatment is the mainstay of management in most patients with asthma [1,2,4]. National and international guidelines advise initiating pharmacologic therapy based on the frequency and severity of symptoms, history of exacerbations requiring systemic glucocorticoids, and results of lung function measurement (asthma severity), and subsequently adjusting therapy up or down, as needed, according to a stepwise approach, to achieve good asthma control [1,2,4].

The choice of medication is based on age of the patient (eg, ≥12 years, 5 to 11 years, 0 to 4 years), symptoms, lung function, risk factors for exacerbations, patient preference, and practical issues (eg, ability to use the medication delivery device, accessibility of medication).

The approach outlined here focuses on treatment of adolescent and adult patients. While management of children with asthma is similar, additional details related to initiating long-term controller medications in children under the age of 12 years, including methods to deliver inhaled medications to very young children, are reviewed separately. (See "Asthma in children younger than 12 years: Overview of initiating therapy and monitoring control" and "Asthma in children younger than 12 years: Management of persistent asthma with controller therapies".)

Initiating therapy during an acute exacerbation — For all patients with symptoms of an asthma exacerbation, we recommend prompt administration of an inhaled short-acting beta-agonist (SABA; eg, albuterol or equivalent). Patients who present with an acute exacerbation of asthma often require an initial, brief course of systemic glucocorticoids, at the same time that long-term controller medication is initiated. Selection of the specific controller medication(s) is based on recent symptoms and may need to be adjusted ("stepped up or stepped down") once the acute exacerbation has resolved. Treatment of asthma exacerbations is reviewed separately. (See "Acute exacerbations of asthma in adults: Home and office management" and "Acute asthma exacerbations in children younger than 12 years: Overview of home/office management and severity assessment" and "Acute asthma exacerbations in children younger than 12 years: Emergency department management".)

Initiating therapy in previously untreated patients — All patients with asthma should have immediate access to an inhaled bronchodilator with a rapid onset of action for prompt relief of asthma symptoms. The traditional choice is a short-acting beta-agonist (SABA; eg, albuterol or levalbuterol). An alternative, as recommended by the Global Initiative for Asthma (GINA), is to use a combination low-dose glucocorticoid-formoterol inhaler (eg, budesonide-formoterol 80 mcg-4.5 mcg or 160 mcg-4.5 mcg), one to two inhalations as needed for asthma symptoms (off-label). This recommendation is based upon the observation that formoterol has a rapid onset of action, equivalent in time course to albuterol, and therefore can be used for quick relief of symptoms (see 'Intermittent (Step 1)' below). Another alternative medication for quick-relief of asthma symptoms is a low-dose glucocorticoid-SABA combination inhaler (budesonide 80 mcg/puff with albuterol 90 mcg/puff).

Initiation of controller therapy for asthma in a stable patient who is not already receiving asthma medication or who is being treated with a SABA alone is based upon the severity of the individual's asthma (for adults and adolescents (table 1); for children 4 to 11 years (table 9); for infants and toddlers (table 10)). (See 'Initial assessment' above.)

Intermittent (Step 1) — Patients with intermittent asthma have traditionally been treated with a SABA, taken as needed for relief of symptoms [1,2]. A novel strategy has been recommended by the Global Initiative for Asthma (GINA): use of a combination inhaler that contains low-dose glucocorticoid and the fast-acting long-acting beta-agonist (LABA), formoterol, taken as needed for symptom relief (off-label in the United States) (table 1) [4]. Formoterol has both a rapid onset and long duration of action (up to 12 hours of bronchodilation). Alternatively, GINA recommends use of a low-dose glucocorticoid inhaler whenever a SABA is used for symptom relief. Although combination ICS-SABA inhalers are undergoing regulatory approval worldwide, including in the United States [42], lack of wide availability means that this latter strategy may require carrying two separate inhalers for intermittent, as-needed use [4]. These novel approaches seek to treat the chronic airway inflammation that is thought to be present even in intermittent asthma and to reduce the risk of severe and potentially life-threatening asthma attacks that can occur in patients with intermittent asthma who rely on treatment with a SABA alone. More extensive discussion of the rationale behind these options is addressed separately. (See "Initiating asthma therapy and monitoring in adolescents and adults" and "Asthma in children younger than 12 years: Quick-relief (rescue) treatment for acute symptoms".)

When triggering of asthma symptoms can be predicted (eg, exercise-induced bronchoconstriction), pretreatment with a SABA (2 inhalations) or an inhaler containing the fast-acting LABA, formoterol, and a glucocorticoid (eg, budesonide-formoterol) 1 to 2 inhalations approximately 5 to 20 minutes prior to exposure is recommended to blunt or prevent the onset of symptoms. An alternative is to use leukotriene receptor antagonists at least two hours before exercise [43], but patients treated with this approach should still carry a rescue inhaler in case of breakthrough symptoms. (See "Exercise-induced bronchoconstriction".)

Mild persistent (Step 2) — For patients with mild persistent asthma, the mainstay of treatment is inhaled glucocorticoids, either as maintenance therapy or as needed for worsening symptoms.

The traditional recommendation for care has been initiation of a regular (daily) low-dose inhaled glucocorticoid controller medication (for adults and adolescents (table 1); for children 4 to 11 years old (table 9); for infants and toddlers (table 10)) (table 15). Regular use of inhaled glucocorticoids reduces the frequency of symptoms (and the need for SABAs for symptom relief), improves the overall quality of life, and decreases the risk of serious exacerbations [44-46].

Disadvantages to regular maintenance inhaled glucocorticoids in this group include lack of perceived symptomatic benefit after each dose of inhaled glucocorticoid, leading to preferential

use of SABA bronchodilator over controller glucocorticoid; patient concerns about the long-term safety of inhaled glucocorticoids and uncertainty of their need in the absence of symptoms; and confusion about the roles and therefore proper use of two different inhalers (which once removed from their packaging do not contain preprinted instructions for use on the inhaler devices themselves). One year after prescription of a daily inhaled glucocorticoid, fewer than 50 percent of patients are using the medication regularly [47]. Alternatives proposed strategies to overcome these disadvantages of daily inhaled glucocorticoid therapy and achieve good asthma control in mild persistent asthma include as-needed use of a combination inhaled glucocorticoid and fast-acting beta-agonist (ie, formoterol or albuterol) [48]; once-daily use of a glucocorticoid-LABA combination, with as needed SABA [49]; and intermittent use of high-dose inhaled glucocorticoids guided by symptoms, with as needed SABA [4,50].

Leukotriene modifiers are an alternative when avoidance of inhaled glucocorticoids is deemed necessary, but efficacy is generally less (table 1 and table 9). The US Food and Drug Administration (FDA) has placed a boxed warning on montelukast regarding potential behavior and mood-related changes. (See "Antileukotriene agents in the management of asthma", section on 'Adverse effects'.)

The pharmacologic management of mild persistent asthma is presented in greater detail elsewhere. (See "Initiating asthma therapy and monitoring in adolescents and adults" and "Asthma in children younger than 12 years: Management of persistent asthma with controller therapies".)

Moderate persistent (Step 3) — For moderate persistent asthma, the preferred controller therapy is a combination low-dose inhaled glucocorticoid and LABA in a single inhaler (for adults and adolescents (table 1); for children 4 to 11 (table 9); for infants and toddlers (table 10)) along with both inhaled glucocorticoid and reliever therapy as needed for acute symptoms.

Because of the rapid onset of action of formoterol, a combination budesonide-formoterol inhaler can be used both for daily controller therapy and for quick relief of symptoms, one recommended strategy is referred to as SMART (Single inhaler Maintenance and Reliever Therapy). It is likely that a combination mometasone-formoterol inhaler can be used in the same way (for both maintenance therapy and for acute relief of symptoms), but fewer data are available with this combination.

This strategy (SMART) has the advantages of: (1) patients are required to master the use of and keep with them one inhaler rather than two; and (2) additional inhaled glucocorticoid is administered when symptoms flare and acute relief of symptoms is needed.

Alternatively, patients can use a low-dose inhaled glucocorticoid-LABA combination inhaler daily and inhaled glucocorticoid and SABA for acute relief of symptoms (for adults (table 16); for children (table 17)). Evidence supports the use of a SABA together with a glucocorticoid, compared with SABA alone, for acute relief of symptoms in patients with moderate persistent asthma on regular controller therapy with combination glucocorticoid-LABA, achieving improved asthma control and a reduced frequency of asthma exacerbations [51,52]. Because use of ICS and SABA together may require two rescue inhalers (until wider available of ICS-SABA combination therapy), use of SABA alone is a frequent alternative. However, this approach is probably suboptimal for maintaining good asthma control.

While LABA use was at one time thought to be associated with an increased risk of severe and life-threatening asthma attacks, subsequent large-scale, randomized trials regarding the use of combination inhalers containing inhaled glucocorticoid and a LABA found no such association, and the "boxed" warning (also called black box warning) that had been included in the package inserts of all LABA products was removed. It remains true that LABAs by themselves should not be used to treat asthma in the absence of concomitant anti-inflammatory therapy, typically an inhaled glucocorticoid. (See "Beta agonists in asthma: Acute administration and prophylactic use", section on 'Long-term maintenance therapy with LABAs'.)

Addition of an inhaled long-acting muscarinic antagonist (LAMA; tiotropium) to an inhaled glucocorticoid has proven equally effective compared to the combination of an inhaled glucocorticoid and LABA [2]. This option is appropriate for any patient intolerant of LABAs or in whom even limited sympathomimetic stimulation is contraindicated, but it requires two separate inhaler devices with distinct inhaler techniques.

An alternative, but overall less effective strategy is addition of a leukotriene modifier (eg, montelukast, zafirlukast) to low-dose inhaled glucocorticoids. We rarely initiate theophylline in the modern treatment of asthma.

The pharmacologic management of moderate persistent asthma is presented in more detail elsewhere. (See "Ongoing monitoring and titration of asthma therapies in adolescents and adults" and "Asthma in children younger than 12 years: Management of persistent asthma with controller therapies".)

Severe persistent (Step 4 or 5) — For severe persistent asthma, the preferred controller treatments are medium (Step 4) or high (Step 5) doses of an inhaled glucocorticoid in combination with a LABA (for adults and adolescents (table 1), for children 4 to 11 (table 9), for infants and toddlers (table 10)). Medium to high doses of inhaled glucocorticoids (table 15) require more careful monitoring for adverse effects (see "Major

side effects of inhaled glucocorticoids"). As in moderate persistent asthma, the use of a SABA together with a glucocorticoid for acute relief of symptoms in patients with severe persistent asthma may improve asthma control and reduce the frequency of asthma exacerbations compared with SABA alone [51,52].

Additional therapy with a leukotriene modifier, LAMA, or biologic agent may be needed, guided by the treatment response. A triple combination inhaler containing an inhaled glucocorticoid, LABA, and LAMA (eg, fluticasone furoate-vilanterol-umeclidinium) has been approved for treatment of severe persistent asthma.

On rare occasion, daily or alternate-day systemic glucocorticoids are needed to treat severe, refractory asthma. The long-term adverse side effects of systemic glucocorticoids are myriad and often devastating. The availability of targeted monoclonal antibodies ("biologics") to treat severe persistent asthma has fortunately made this subset of "steroid-dependent" patients progressively smaller. (See "Major adverse effects of systemic glucocorticoids".)

Treatment options for severe asthma are discussed in greater detail separately. (See 'Stepping up therapy in poorly controlled asthma' below and "Asthma in children younger than 12 years: Management of persistent asthma with controller therapies", section on 'Moderate-to-severe, persistent asthma' and "Treatment of severe asthma in adolescents and adults" and "Asthma in children younger than 12 years: Management of persistent asthma with controller therapies", section on 'Step-up therapy for severe asthma'.)

FOLLOW-UP MONITORING

Effective asthma management requires a proactive, preventive approach, similar to the treatment of hypertension or diabetes.

Approach to monitoring — Routine follow-up visits for patients with active asthma are recommended, at a frequency of every one to six months, depending upon the severity of asthma and adequacy of control. Follow-up visits should be used to assess asthma control, lung function, exacerbations, inhaler technique, adherence, medication adverse effects, quality of life, and patient satisfaction with care [3].

By consensus from panels of asthma experts, well-controlled asthma is characterized by daytime symptoms no more than twice per week and nighttime awakening due to asthma no more than twice per month [4]. Asthma symptoms requiring reliever medication (eg, short-acting beta-agonist [SABA]) should occur at most two days out of the week (not including pretreatment before exercise), and there should be no interference with normal activity.

Pretreatment with a SABA to prevent exercise-induced bronchoconstriction is generally not counted, although the need for daily SABA to prevent exercise-induced bronchoconstriction suggests suboptimal control that often warrants addition of controller medication [4,53]. (See "Exercise-induced bronchoconstriction", section on 'Persistent EIB symptoms despite premedication'.)

Peak expiratory flow and spirometry should remain normal or near normal (or, when a patient's optimal baseline lung function is abnormal, at or close to the individual's personal best peak flow or forced expiratory volume in one second [FEV_1]). Oral glucocorticoid courses and/or urgent care visits should be needed no more than once per year [54]. Approaches to assessment of asthma control in adults and children are summarized in the tables (for adults and adolescents (table 11); for children 4 to 11 (table 12); for infants and toddlers (table 13)).

Symptom and risk assessment — Symptoms over the past four weeks should be assessed at each visit. Assessment should address daytime symptoms, nighttime awakening due to asthma symptoms, frequency of use of SABAs to relieve symptoms, and difficulty in performing normal activities and exercise (for adults and adolescents (table 11); for children 4 to 11 (table 12); for infants and toddlers (table 13)). Several quick and validated questionnaires, like the Asthma Control Test for children (figure 1) and adults (form 3), provide standardized methods for scoring asthma control and recording changes over time [4,55-65].

- **Assessment of impairment** – The following questions are representative of those used in validated questionnaires to assess asthma control:
  - How often has your asthma awakened you at night or in the early morning?
  - How often have you been needing to use your quick-acting relief medication for symptoms of cough, shortness of breath, or chest tightness?
  - Have you needed any unscheduled care for your asthma, including calling in, an office or urgent care visit, or an emergency department visit?
  - Have you been able to participate in school/work and recreational activities as desired?
  - If you are measuring your peak flow, has it been lower than your personal best? Home monitoring of peak flow measurements is reviewed in detail separately. (See "Peak expiratory flow monitoring in asthma".)
- **Assessment of risk** – The following questions can be used to address the most important risk factors for future exacerbations [1]. A discussion of the risk factors for fatal and near-

fatal asthma is provided separately. (See "Identifying patients at risk for fatal asthma", section on 'Identifying high-risk patients'.)

- Have you taken oral glucocorticoids ("steroids") for your asthma in the past year?
- Have you been hospitalized for your asthma? If yes, how many times have you been hospitalized in the past year?
- Have you been admitted to the intensive care unit or been intubated because of your asthma? If yes, did this occur within the past five years?
- Do you currently vape or smoke cigarettes or does anyone in your household? If so, how many each day?

Other factors that are also associated with fatal asthma (eg, aeroallergen exposure, food allergy, illicit drug use) may increase risk in individual patients. (See "Identifying patients at risk for fatal asthma", section on 'Minor risk factors'.)

Follow-up visits should also include inquiry about any adverse effects from or concerns about asthma medications. It is worth regularly revisiting the patient's use of inhaled medications to ensure that they are not empty or expired, are being inhaled properly, and where appropriate (especially with the use of inhaled glucocorticoids via metered-dose inhalers), include use of a valved-holding chamber ("spacer") to optimize medication delivery to the airways and minimize deposition in the oropharynx.

Pulmonary function — Spirometry is the preferred method for monitoring pulmonary function in children older than approximately five years of age and adults; assessing peak expiratory flow (PEF) with a peak flow meter is an alternative. Guidelines prefer use of spirometry over peak flow in medical offices, when available, due to greater accuracy of the measurement, when carefully performed by skilled technical staff [1]. Spirometry cannot be performed reliably by most children younger than six years. It is our practice to obtain a measurement of lung function (peak flow or spirometry) at every visit in our patients with asthma.

Office monitoring — Spirometry, which measures FEV_1 and forced vital capacity (FVC), is a sensitive and reproducible method for assessing airflow limitation, defined as a reduced FEV_1/FVC ratio. Spirometry can detect reductions in lung function, indicating loss of asthma control and risk of a severe asthma exacerbation, particularly in patients who have few symptoms or physical findings of asthma [66,67]. We typically obtain spirometry approximately every one to two years when asthma is stable, but more frequently if asthma is not well-controlled or medications are being adjusted. Hand-held spirometers with disposable

mouthpieces may allow expanded use in office settings. (See "Office spirometry" and "Pulmonary function testing in asthma" and "Overview of pulmonary function testing in children", section on 'Use of spirometry in asthma'.)

In patients with asthma in whom airway obstruction has been established by spirometry, peak flow measurement using handheld peak flow meters can be used as an alternative for longitudinal monitoring. Peak flow monitoring is best used to assess changes over time and for detecting severe obstruction in a patient who may not have wheezing or complain of troublesome symptoms. Reliable PEF measurements can be made with minimal training; the costs in terms of equipment, staff, and time are minimal. Periodically, PEF values measured by peak flow meter should be correlated with peak flow measurement made via spirometry. Normal values for men, women, and adolescents are listed in the table or can be calculated (table 18 and table 19) (calculator 1 and calculator 2); normal values for children can be calculated (calculator 3 and calculator 4).

It is important to understand the limitations of PEF. A reduced peak flow is not synonymous with airway obstruction. Spirometry is needed to differentiate an obstructive from restrictive abnormality [68]. Peak flow may underestimate the severity of airflow obstruction as revealed by spirometry (figure 2). Also, the accuracy of a single peak flow measurement to detect the presence of airflow obstruction is limited, given the large variability of PEF among healthy individuals of the same age, height, and sex (±20 percent) [68]. The use of PEF monitoring and its limitations are presented in more detail separately. (See "Peak expiratory flow monitoring in asthma".)

Home monitoring — Home monitoring with repeated measurements of PEF or FEV_1 over time may be useful for determining relative changes or trends in asthma control in adults and adolescents with moderate to severe persistent asthma, but is rarely used for children [1,4]. Home monitoring may be particularly helpful in patients who have poor perception of airflow limitation. These individuals cannot be easily identified at the outset of care, although over time they display a lack of awareness of increasing impairment, and typically seek care for exacerbations only after symptoms have become severe [69,70]. (See "Identifying patients at risk for fatal asthma".)

Peak flow meters for individual use are widely available, inexpensive (approximately $20), and easy to use. However, measurements are highly dependent upon the patient's technique. It is therefore important that the patient's technique be assessed in the office and any mistakes in technique corrected. Instructions for use of a PEF meter are provided separately. (See "Patient education: How to use a peak flow meter (Beyond the Basics)".)

Ideally, the patient should establish a baseline value of peak flow or FEV_1, using morning and evening measurements over the course of a week or two when feeling entirely well: the "personal best" peak flow value. A chart for recording PEF values at home is available for download. The personal best PEF is then used to determine the normal PEF range, which is between 80 and 100 percent of the patient's personal best. Readings below this normal range indicate airway narrowing, a change that may occur before symptoms are perceived by the patient. (See 'Asthma action plan' above.)

Other

- **Airway inflammation** – Methods to assess airway inflammation, such as blood and sputum eosinophil counts, total serum immunoglobulin E (IgE), and fractional exhaled nitric oxide (FE_{NO}), are less widely employed for disease monitoring. These tests are used in selected patients to determine the likelihood of response to a change in inhaled glucocorticoid dose or candidacy for one of the biologic therapies (eg, monoclonal antibodies targeting IgE, interleukin [IL]-5 or its receptor, or the alpha subunit of the IL-4 receptor). Studies have reached conflicting conclusions about whether regularly measuring markers such as FE_{NO} might help optimize asthma management. The use of expectorated sputum eosinophilia and exhaled nitric oxide analysis in the management of asthma are discussed in more detail separately. (See "Evaluation of severe asthma in adolescents and adults", section on 'Airway inflammation' and "Exhaled nitric oxide analysis and applications".)

- **Comorbid conditions** – Comorbid conditions can contribute to asthma symptoms, depending on the specific condition. In adults, these conditions include rhinitis/sinusitis, chronic obstructive pulmonary disease (COPD)/emphysema, allergic bronchopulmonary aspergillosis, gastroesophageal reflux, obesity, obstructive sleep apnea, inducible laryngeal obstruction (also called vocal cord dysfunction), and depression/chronic stress. In addition, there is increasing awareness about the impact of the social determinants of health (including poor housing conditions, increased exposure to air pollution, and lack of ready access to medications and medical care) on the course of asthma. These conditions are reviewed separately. (See "An overview of rhinitis" and "Chronic rhinosinusitis: Clinical manifestations, pathophysiology, and diagnosis" and "Chronic obstructive pulmonary disease: Diagnosis and staging" and "Clinical manifestations and diagnosis of allergic bronchopulmonary aspergillosis" and "Gastroesophageal reflux and asthma" and "Obesity and asthma" and "Clinical presentation and diagnosis of obstructive sleep apnea in adults" and "Inducible laryngeal obstruction (paradoxical vocal fold motion)".)

ADJUSTING CONTROLLER MEDICATION

For patients already taking one or more controller medications, therapy is adjusted in a stepwise fashion, increasing medication until asthma is controlled and then decreasing medication when possible to minimize adverse effects. The therapeutic tiers, or "steps," are as described in the National Asthma Education and Prevention Program (NAEPP) and Global Initiative for Asthma (GINA) guidelines (for adults and adolescents (table 1); for children 4 to 11 (table 9); for infants and toddlers (table 10)). Stepping up and down is based on the degree of asthma control and risk for future exacerbations as described above (for adults and adolescents (table 11); for children 4 to 11 (table 12); for infants and toddlers (table 13)). (See 'Follow-up monitoring' above.)

Therapy should be reassessed at each visit because asthma is an inherently variable condition, and the management of asthma is a dynamic process that changes over time in accordance with the patient's needs.

Asthma control is assessed based on impairment over the past two to four weeks (as determined by history or a validated questionnaire), current forced expiratory volume in one second (FEV_1) or peak flow, and estimates of risk [1,71].

Adjusting therapy in children younger than 12 years is reviewed in more detail separately. (See 'Follow-up monitoring' above and "Asthma in children younger than 12 years: Overview of initiating therapy and monitoring control", section on 'Monitoring and dosing adjustment' and "Asthma in children younger than 12 years: Management of persistent asthma with controller therapies".)

Stepping up therapy in poorly controlled asthma — In patients with poorly controlled asthma (for adults and adolescents (table 11); for children 4 to 11 (table 12); for infants and toddlers (table 13)), treatment should be "stepped up" according to NAEPP or GINA tiers (for adults and adolescents (table 1); for children 4 to 11 (table 9); for infants and toddlers (table 10)) [4]. In patients with very poorly controlled asthma, it may be necessary to escalate therapy more than one step, and then "step-down" again once good control is achieved.

In treating severe asthma, many providers add a long-acting muscarinic antagonist (LAMA; eg, tiotropium) and/or a leukotriene modifier to the combination inhaled glucocorticoid and long-acting beta-agonist (LABA). Patients with severe asthma should be referred to an asthma specialist, if available. If these patients remain poorly controlled, a biologic therapy may be considered to avoid oral glucocorticoids. Severe asthma is reviewed in more detail separately. (See "Treatment of severe asthma in adolescents and adults".)

The availability of monoclonal antibodies targeting key molecules involved in airway inflammation in asthma has revolutionized the treatment of patients with severe asthma. These are reviewed briefly here and discussed in greater detail separately. (See "Treatment of severe asthma in adolescents and adults", section on 'Selecting among biologic agents'.)

- **Anti-IgE therapy** – For patients whose asthma is inadequately controlled on medium- to high-dose inhaled glucocorticoids and LABAs, the anti-immunoglobulin E (IgE) therapy omalizumab may be considered if there is objective evidence of sensitivity to a perennial allergen (by allergy skin tests or in vitro measurements of allergen-specific IgE) and if the serum total IgE level is within the established target range (based on patient weight and serum total IgE level). (See "Anti-IgE therapy".)

- **Anti-eosinophilic therapy** – Interleukin 4 (IL-4), IL-5, and IL-13 promote pulmonary eosinophilia through distinct mechanisms, including selective recruitment and cellular survival pathways. IL-4 also stimulates the production of IgE by its action on B cells. Monoclonal antibodies against IL-5 (mepolizumab and reslizumab), IL-5 receptor alpha (benralizumab), and IL-4 receptor alpha subunit (dupilumab) are available for treatment of severe eosinophilic asthma that is poorly-controlled with conventional therapy. (See "Treatment of severe asthma in adolescents and adults", section on 'Anti-IL-5 therapy' and "Treatment of severe asthma in adolescents and adults", section on 'Anti-lL-4 receptor alpha subunit antibody (dupilumab)'.)

- **Anti-thymic stomal lymphopoietin therapy** – Thymic stromal lymphopoietin (TSLP) promotes type 2 inflammation in asthma. Anti-TSLP is approved for adolescents and adults with severe asthma irrespective of peripheral blood eosinophil count, although patients with higher eosinophil counts tend to have a better response. (See "Treatment of severe asthma in adolescents and adults", section on 'Anti-thymic stromal lymphopoietin (tezepelumab)'.)

Bronchial thermoplasty is a device-based intervention available in specialized centers to treat severe asthma. Using a special catheter introduced via a fiberoptic bronchoscope, thermal energy is applied to bronchial walls in an effort to impair bronchial smooth muscle contractility. The role of bronchial thermoplasty in managing severe asthma remains debated. The 2020 Focused Updates of the NAEPP recommends against the use of bronchial thermoplasty outside of a clinical trial or database registry [2]. (See "Treatment of severe asthma in adolescents and adults", section on 'Bronchial thermoplasty'.)

Stepping down therapy — For patients whose asthma has been well-controlled for three to six months on a stable regimen (for adults and adolescents (table 11); for children 4 to 11

(table 12); for infants and toddlers (table 13)), controller medications can be reduced in a step-wise fashion based on NAEPP or GINA tiers (for adults and adolescents (table 1); for children 4 to 11 (table 9); for infants and toddlers (table 10)). Besides minimizing expense, inconvenience, and potential immediate adverse effects, the purpose of stepping down therapy in some patients is reducing long-term exposure to high doses of inhaled glucocorticoids, with their potential for systemic absorption and adverse effects on organs such as bones, eyes, and skin. Careful monitoring as therapy is stepped down is needed to identify, and respond to, any deterioration in control. Complete cessation of inhaled glucocorticoids should be approached with caution, as it is likely to lead to clinical deterioration in patients with persistent asthma [31]. Alternatively, in follow-up of well-controlled asthma, medications can be continued unchanged, especially if history reveals serious exacerbations in the past or a high risk of future exacerbation.

WHEN TO REFER

Both pulmonologists and allergists/immunologists have specialty training in asthma care. Referral for consultation or comanagement depends on the level of experience and comfort of the primary care provider with asthma care, but is generally advisable when any of the following circumstances arise [1,4]:

- Difficulty confirming a diagnosis of asthma
- History of a life-threatening asthma exacerbation (eg, intensive care unit admission, mechanical ventilation for asthma)
- Hospitalization for asthma, more than two courses of oral glucocorticoids in a year, or inability to discontinue oral glucocorticoids
- Need for step 5 care or higher
- Poor asthma control after three to six months of active therapy and appropriate monitoring
- Anaphylaxis or confirmed food allergy in a patient with asthma
- Presence of complicating comorbidity (eg, aspirin-exacerbated respiratory disease (AERD), nasal polyposis, chronic rhinosinusitis, allergic bronchopulmonary aspergillosis (ABPA), chronic obstructive pulmonary disease (COPD), inducible laryngeal obstruction [also called vocal cord dysfunction])

- Need for additional diagnostic tests (eg, allergy skin testing, bronchoscopy, complete pulmonary function tests)
- Consideration of allergen immunotherapy (see "Subcutaneous immunotherapy (SCIT) for allergic rhinoconjunctivitis and asthma: Indications and efficacy")
- Potential candidacy for therapy with biologics (benralizumab, dupilumab, mepolizumab, omalizumab, reslizumab, tezepelumab) or bronchial thermoplasty

Other possible indications for referral include [1,4]:

- Need for step 4 care in an adult or child older than five years
- Need for step 2 care or higher in a child under five years
- Evaluate potential occupational triggers
- Patients in whom psychosocial or psychiatric problems are interfering with asthma management and in whom referral to other appropriate specialists may be required

SOCIETY GUIDELINE LINKS

Links to society and government-sponsored guidelines from selected countries and regions around the world are provided separately. (See "Society guideline links: Asthma in adolescents and adults" and "Society guideline links: Severe asthma in adolescents and adults" and "Society guideline links: Asthma in children" and "Society guideline links: Exercise-induced bronchoconstriction".)

INFORMATION FOR PATIENTS

UpToDate offers two types of patient education materials, “The Basics” and “Beyond the Basics.” The Basics patient education pieces are written in plain language, at the 5th to 6th grade reading level, and they answer the four or five key questions a patient might have about a given condition. These articles are best for patients who want a general overview and who prefer short, easy-to-read materials. Beyond the Basics patient education pieces are longer, more sophisticated, and more detailed. These articles are written at the 10th to 12th grade reading level and are best for patients who want in-depth information and are comfortable with some medical jargon.

Here are the patient education articles that are relevant to this topic. We encourage you to print or e-mail these topics to your patients. (You can also locate patient education articles on a variety of subjects by searching on “patient info” and the keyword(s) of interest.)

- Basics topics (see "Patient education: How to use your child's dry powder inhaler (The Basics)" and "Patient education: Asthma in children (The Basics)" and "Patient education: How to use your child's metered dose inhaler (The Basics)" and "Patient education: Asthma and pregnancy (The Basics)" and "Patient education: How to use your dry powder inhaler (adults) (The Basics)" and "Patient education: How to use your metered dose inhaler (adults) (The Basics)" and "Patient education: How to use your soft mist inhaler (adults) (The Basics)" and "Patient education: Asthma in adults (The Basics)" and "Patient education: Avoiding asthma triggers (The Basics)" and "Patient education: Medicines for asthma (The Basics)" and "Patient education: Coping with high drug prices (The Basics)" and "Patient education: Inhaled corticosteroid medicines (The Basics)")

- Beyond the Basics topics (see "Patient education: Asthma inhaler techniques in children (Beyond the Basics)" and "Patient education: Asthma treatment in children (Beyond the Basics)" and "Patient education: Asthma and pregnancy (Beyond the Basics)" and "Patient education: Asthma symptoms and diagnosis in children (Beyond the Basics)" and "Patient education: How to use a peak flow meter (Beyond the Basics)" and "Patient education: Inhaler techniques in adults (Beyond the Basics)" and "Patient education: Asthma treatment in adolescents and adults (Beyond the Basics)" and "Patient education: Exercise-induced asthma (Beyond the Basics)" and "Patient education: Trigger avoidance in asthma (Beyond the Basics)" and "Patient education: Coping with high prescription drug prices in the United States (Beyond the Basics)")

SUMMARY AND RECOMMENDATIONS

- **Goals of treatment** – The goals of asthma treatment are to reduce impairment from symptoms, attenuate the risk of adverse outcomes associated with asthma (eg, hospitalizations, loss of lung function), and minimize adverse effects from asthma medications. (See 'Goals of asthma treatment' above.)

- **Patient education and action plan** – Patients should learn to monitor asthma control at home, including the frequency and severity of dyspnea, cough, chest tightness, and the need for quick-relief medication. The technique for using each type of inhaler should be demonstrated and reviewed with the patient. Adult and adolescent patients with moderate to severe asthma and those with poor perception of increasing asthma symptoms may

benefit from measurement of their peak expiratory flow (PEF) or forced expiratory volume in first second of exhalation (FEV_1) at home. (See 'Components of asthma education and self-management' above and "Asthma education and self-management".)

A personalized asthma action plan should be provided with detailed instructions about adjusting asthma medications based upon changes in symptoms and/or lung function (form 1 and form 2). (See 'Asthma action plan' above.)

Environmental triggers (table 7) and coexisting conditions that interfere with good asthma control should be identified and addressed for each patient. (See 'Controlling asthma triggers' above and 'Other' above and "Trigger control to enhance asthma management" and "Allergen avoidance in the treatment of asthma and allergic rhinitis" and "Subcutaneous immunotherapy (SCIT) for allergic rhinoconjunctivitis and asthma: Indications and efficacy".)

- **Initiating pharmacologic therapy** – Pharmacologic therapy is determined by the degree of asthma severity and asthma control.

  - **Quick-relief medication** – All patients with asthma should have immediate access to an inhaled bronchodilator with a rapid onset of action for prompt relief of asthma symptoms. The traditional choice, most appropriate for patients with mild disease, infrequent symptoms, and absence of serious exacerbations, is a short-acting beta-agonist (SABA; eg, albuterol or levalbuterol). An alternative approach, most appropriate for patients for patients with moderate or severe persistent asthma and for patients with intermittent or mild persistent asthma but a history of serious exacerbations or erratic medical care, is to use a low-dose glucocorticoid together with a fast-acting beta-agonist (formoterol, albuterol, or levalbuterol). Combination inhalers (eg, budesonide-formoterol, mometasone-formoterol, budesonide-albuterol) are available. (See 'Initiating therapy in previously untreated patients' above and "Asthma in children younger than 12 years: Overview of initiating therapy and monitoring control" and "Asthma in children younger than 12 years: Quick-relief (rescue) treatment for acute symptoms" and "Initiating asthma therapy and monitoring in adolescents and adults".)

  - **Controller medication** – Initial maintenance therapy is based on assessment of asthma severity (for adults and adolescents (table 1); for children 4 to 11 (table 9); for infants and toddlers (table 10)), whereas adjustment of therapy is based on asthma control, which includes components of current impairment and future risk (for adults and adolescents (table 11); for children 4 to 11 (table 12); for infants and toddlers (table 13)). Asthma control can be judged, irrespective of medication use,

based on the current level of symptoms, forced expiratory volume in one second (FEV_1) or PEF values, and number of exacerbations requiring oral glucocorticoids in the preceding year. National (NAEPP) and international (GINA) guidelines offer a step-care approach to escalating medications until good asthma control is achieved. In well-controlled asthma, it may be possible to "step-down" the intensity of medical treatment without loss of asthma control, with a particular goal of minimizing long-term exposure to high-dose inhaled glucocorticoids. (See 'Initial assessment' above and 'Initiating pharmacologic treatment' above and "Asthma in children younger than 12 years: Overview of initiating therapy and monitoring control" and "Asthma in children younger than 12 years: Management of persistent asthma with controller therapies" and "Initiating asthma therapy and monitoring in adolescents and adults" and "Ongoing monitoring and titration of asthma therapies in adolescents and adults" and "Treatment of severe asthma in adolescents and adults".)

- **Follow-up monitoring** – Effective asthma management requires a preventive approach, with regularly scheduled visits during which symptoms are assessed, pulmonary function measured, control of exposure to asthma triggers and impact of comorbid conditions reviewed, medications adjusted, and ongoing education provided. (See 'Follow-up monitoring' above.)

  Therapy is adjusted up or down as needed based on assessment of asthma control regimen (for adults and adolescents (table 11); for children 4 to 11 (table 12); for infants and toddlers (table 13)) using the GINA or NAEPP step-wise regimens (for adults and adolescents (table 1); for children 4 to 11 (table 9); for infants and toddlers (table 10)). Detailed management of therapeutic adjustment are discussed separately. (See 'Adjusting controller medication' above and "Asthma in children younger than 12 years: Overview of initiating therapy and monitoring control", section on 'Monitoring and dosing adjustment' and "Asthma in children younger than 12 years: Management of persistent asthma with controller therapies", section on 'Step-up therapy for mild-to-moderate asthma' and "Asthma in children younger than 12 years: Management of persistent asthma with controller therapies", section on 'Step-up therapy for severe asthma' and "Initiating asthma therapy and monitoring in adolescents and adults" and "Ongoing monitoring and titration of asthma therapies in adolescents and adults" and "Treatment of severe asthma in adolescents and adults", section on 'Adjusting controller therapy' and "Treatment of severe asthma in adolescents and adults", section on 'Persistently uncontrolled asthma'.)

- **Specialist referral** – Guidelines for specialist referral to a pulmonologist or allergist/immunologist include uncertainty about the diagnosis of asthma, poorly-controlled asthma, an episode of near-fatal asthma, need for specialized diagnostic studies (eg, allergy skin testing, bronchoscopy), potential treatment with biologics, or treatment of comorbid conditions. (See 'When to refer' above.)

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Topic 547 Version 76.0

GRAPHICS

Guideline approaches to initial asthma therapy in adolescents and adults

National Asthma Education and Prevention Program: Expert Panel Working Group[1,2]		Global Initiative for Asthma (GINA)[3]	
Asthma symptoms/lung function	**Therapy***	**Asthma symptoms**	**Therapy**
Step 1		**Step 1**	
All of the following: ▪ Daytime symptoms ≤2 days/week ▪ Nocturnal awakenings ≤2/month ▪ Normal FEV_1 ▪ Exacerbations ≤1/year	▪ SABA, as needed	▪ Infrequent asthma symptoms (eg, <2 times/week) ▪ No risk factors for exacerbations¶	▪ Low-dose ICS-formoterol as needed (preferred)Δ **or** ▪ Low-dose ICS whenever SABA used or as-needed low-dose ICS-SABAΔ
Step 2		**Step 2**	
Any of the following: ▪ Daytime symptoms >2 but <7 days/week ▪ Nocturnal awakenings up to 3 to 4 nights/month ▪ Minor interference with activities ▪ Exacerbations ≥2/year	▪ Low-dose ICS daily **and** SABA as needed **or** ▪ Low-dose ICS-SABA or ICS **plus** SABA, concomitantly administered, as neededΔ **Alternative option(s)** ▪ Daily LTRA **and** SABA as needed	▪ Asthma symptoms or need for reliever inhaler ≥2 times/week, but without troublesome daily symptoms	▪ Low-dose ICS-formoterol as needed (preferred) **or** ▪ Low-dose ICS daily **and** SABA as needed **Other options** ▪ Low-dose ICS-SABA or ICS **plus** SABA, concomitantly administered, as needed **or** (less preferred) ▪ LTRA daily **and** SABA as needed
Step 3		**Step 3**	

Any of the following: ▪ Daily symptoms ▪ Nocturnal awakenings >1/week ▪ Daily need for reliever ▪ Some activity limitation ▪ FEV_1 60 to 80% predicted ▪ Exacerbations ≥2/year	▪ Low-dose ICS-formoterol as maintenance and reliever therapy◇ (preferred) **Alternative option(s)** ▪ Medium-dose ICS daily **and** SABA as needed **or** ▪ Low-dose ICS-LABA combination daily **or** low-dose ICS **plus** LAMA daily **or** low-dose ICS **plus** anti-leukotriene daily **and** SABA as needed	▪ Troublesome asthma symptoms most days, nocturnal awakening due to asthma ≥1 time/month, multiple risk factors for exacerbations¶	▪ Low-dose ICS-formoterol as maintenance and reliever therapy◇ (preferred) **or** ▪ Low-dose ICS-LABA combination daily **and** SABA as needed **Other options** ▪ Medium-dose ICS daily **and** SABA or ICS-SABAΔ as needed **or** ▪ Low-dose ICS plus LTRA daily **and** SABA or ICS-SABAΔ as needed
Step 4		**Step 4**	
Any of the following: ▪ Symptoms all day ▪ Nocturnal awakenings nightly ▪ Need for SABA several times/day ▪ Extreme limitation in activity ▪ FEV_1 <60% predicted ▪ Exacerbations ≥2/year ▪ An acute exacerbation	▪ Medium-dose ICS-formoterol as maintenance and reliever therapy◇ (preferred) **Alternative option(s)** ▪ Medium-dose ICS-LABA daily or medium-dose ICS **plus** LAMA daily **or** Medium-dose ICS daily **plus** anti-leukotriene **and** SABA as needed*	Severely uncontrolled asthma with ≥3 of the following: ▪ Daytime asthma symptoms >2 times/week ▪ Nocturnal awakening due to asthma ▪ Reliever needed for symptoms >2 times/week ▪ Activity limitation due to asthma	▪ Medium-dose ICS-formoterol as maintenance and reliever therapy◇ (preferred) **or** ▪ Medium dose ICS-LABA daily **and** SABA or ICS-SABAΔ as needed **Other options** ▪ Possible add-on LAMA or switch to ICS-LAMA-LABA ▪ Possible add-on LTRA

This table illustrates major guideline recommendations for initial asthma therapy. These recommendations are used for newly diagnosed patients or for patients using SABA therapy alone. For additional information, please refer to UpToDate content on initial treatment of asthma.

DPI: dry powder inhaler; FEV_1: forced expiratory volume in one second; ICS: inhaled corticosteroid (glucocorticoid); IgE: immunoglobulin E; IL: interleukin; LABA: long-acting beta-agonist; LAMA: long-acting muscarinic antagonist; LTRA: leukotriene receptor antagonist; MDI: metered-dose inhaler; SABA: short-acting beta-agonist.

* Theophylline and cromolyn are not included in the table even though they were included in NAEPP-EPR 3 (2007), and theophylline is included in NAEPP (2020). These agents are rarely used now, due to availability of more effective options.

¶ Risk factors for exacerbations include: frequent asthma symptoms, prior asthma exacerbations, smoking, allergen exposure if sensitized, previous intubation or intensive care unit stay for asthma, low FEV_1 (especially <60% predicted), obesity, food allergy, chronic rhinosinusitis, and poor adherence/inhaler technique. Please refer to UpToDate asthma treatment content and separate graphic on risk factors for asthma exacerbation.

Δ When prescribed for use as-needed for acute asthma symptoms, ICS-formoterol, ICS-SABA, and concomitant ICS and SABA are referred to as anti-inflammatory reliever therapy (AIR). Compared with SABA relievers, use of AIR has demonstrated decreased exacerbation risk in patients with all degrees of asthma severity. Choice of therapy is also guided by patient preference, cost, and medication availability.

◇ ICS-formoterol prescribed for use as both maintenance therapy and for acute relief of symptoms is referred to as Maintenance and Reliever Therapy (MART). MART has been shown to be more effective in terms of exacerbation reduction and symptom relief compared with ICS-formoterol and SABA alone as reliever therapy. Choice of therapy is also guided by patient preference, cost, and medication availability.

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Graphic 127798 Version 8.0

Technique for use of a pressurized metered dose inhaler (MDI) without a space or chamber

Remove the cover of the mouthpiece.
Prime your inhaler if this is the first time you are using it, if you have not used it for several days, or if you have dropped it. Priming an MDI usually involves shaking it and spraying it into the air (away from your face) a total of up to 4 times. See the information that came with your inhaler for exact instructions.
Shake MDI canister vigorously for 5 seconds.
Hold the MDI upright with your index finger on the top of the medication canister and your thumb supporting the bottom of the inhaler.
Breathe out normally.
Put the mouthpiece between your teeth and close your lips around mouthpiece or position mouthpiece approximately 4 cm (approximately width of 2 fingers) from your mouth.
Keep your tongue away from the opening of the mouthpiece.
Press down the top of the canister with the index finger to release the medication.
At the same time as the canister is pressed, breathe in deeply and slowly through your mouth until your lungs are completely filled; this should take 4 to 6 seconds.
Hold the medication in your lungs for as long as comfortable (approximately 5 to 10 seconds) before breathing out.
If you need a second puff, wait approximately 15 to 30 seconds between puffs. Shake canister again before the next puff.
When finished, recap mouthpiece.
If your inhaler contains a steroid medicine (sometimes called glucocorticoid or corticosteroid), rinse your mouth and gargle with water after you use it. Then spit out the water. Do not swallow it.

We prefer to use metered dose inhalers (MDIs) with a spacer or holding chamber. Instructions for use of MDIs with these devices is provided in a separate graphic.

These instructions do **not** apply to dry powder or soft mist inhalers. Cleaning instructions are provided separately.

More detailed information about individual medication formulations can be found at http://www.accessdata.fda.gov/scripts/cder/drugsatfda/index.cfm.

Graphic 103302 Version 8.0

Technique for use of a pressurized metered dose inhaler (MDI) with a spacer or chamber*

Uncap mouthpiece and check for loose objects in the device.
Prime your inhaler if this is the first time you are using it, if you have not used it for several days, or if you have dropped it. Priming an MDI usually involves shaking it and spraying it into the air (away from your face) a total of up to 4 times. See the information that came with your inhaler for exact instructions.
Insert MDI into spacer.
Shake canister vigorously for approximately 5 seconds.
Hold the MDI upright with your index finger on the top of the medication canister and your thumb supporting the bottom of the inhaler. You may need to use the other hand to hold the spacer.
Breathe out normally through your mouth.
Put the mouthpiece between your teeth and close your lips tightly around mouthpiece of spacer. (If using mask attached to the chamber, place the mask completely over your nose and mouth.)
Make sure your tongue does not block the opening of the mouthpiece of the spacer.
Press down the top of the canister with your index finger to release the medicine.
At the same time, breathe in deeply and slowly through your mouth until your lungs are completely filled; this should take 3 to 5 seconds.
Hold the medicine in your lungs for approximately 5 to 10 seconds. If you did not get a full breath or cannot hold your breath long enough, you can inhale a second time to fully empty the chamber and hold your breath again for approximately 5 seconds. For infants and young children, or if unable to cooperate with a deep breath or breath-holding, 5 to 6 normal breaths will allow complete emptying of the chamber.
If you need more than one puff, wait approximately 15 to 30 seconds between puffs. Shake canister again before the next puff. Do **not** load both puffs into the chamber and then empty the chamber with a single inhalation.
When finished, recap mouthpiece.
If your inhaler contains a steroid medicine (sometimes called glucocorticoid or corticosteroid), rinse your mouth and gargle with water after you use it. Then spit out the water. Do not swallow it.
You can use your spacer for more than 1 medication. Just remove the first MDI and insert the other one.

These instructions do **not** apply to dry powder or soft mist inhalers. Cleaning instructions are provided separately.

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* We prefer to use a "valved holding chamber" for the spacer (eg, AeroChamber, Easivent, Optichamber, Vortex). The valve holds the medicine in the chamber until you take your deep breath in. This helps get the medicine into your lungs. Also, when you breathe out into the mouthpiece, the valve prevents your

breath from going into the chamber. If your spacer does not have this valve, you should breathe out through your nose or remove the spacer from your mouth before breathing out.

Graphic 103303 Version 9.0

Technique for use of various dry powder inhalers*

Load a dose of medicine
▪ For single-dose inhalers, load a dose by taking a pill out of its packaging and putting the pill into the inhaler. Then push 1 or more buttons on the inhaler to poke holes in the pill.
▪ For multiple-dose inhalers, load a dose by sliding a lever or twisting part of the inhaler. Loading a dose should decrease the counter on the device by one. This means a dose is ready to be inhaled.
▪ Once the dose is loaded, maintain your inhaler in the correct position - some inhalers need to be held upright, but others need to be horizontal. The dose may be lost or spilled if the inhaler is tipped over after loading.
Medication delivery
▪ Open the device or take off the cap to expose the mouthpiece, if necessary.
▪ While holding the inhaler away from your mouth, breathe out (exhale) fully. Do not exhale into the mouthpiece.
▪ Put the mouthpiece between your lips. Breathe in quickly and steadily through your mouth, as deeply as possible. Do not breathe in through your nose. You might not taste or feel the medicine, even when you are using the inhaler correctly. If your device has air vent holes, do not cover those holes while inhaling through the device.
▪ Remove the device from your mouth and hold your breath for about 10 seconds (or as long as you comfortably can).
▪ Breathe out slowly (away from the mouthpiece).
▪ If you are supposed to take 2 puffs of your inhaler, load/activate another dose and breathe it in.
▪ Rinse your mouth out with water, gargle, and spit out the water.
Device maintenance and storage
▪ After use, close your inhaler or replace the cover or cap. Make sure the device is fully closed before storing.
▪ For single dose inhalers, you often need to dispose of the used dose. Please refer to the package insert.
▪ Pay attention to the number of doses you have remaining. For multi-dose devices, observe the counter to determine when you need a refill on the device. For single dose devices, monitor the number of individual doses remaining.
▪ Store your inhaler in a cool, dry place.

- Dry powder inhalers generally do not require internal cleaning. The mouthpiece may be wiped off with a dry cloth. Please refer to the package insert for additional device-specific instructions.

* Each dry powder inhaler comes with its own directions. Although the general technique is similar, various devices are loaded and activated differently. Some devices load each dose separately, while others contain a month's worth of medication and do not require loading. Refer to the package insert of each device or to the manufacturer website for additional instructions.

Graphic 51020 Version 13.0

Techniques for use of various dry powder inhalers in children

Digihaler
Hold the inhaler in an upright position and open the cap. A "click" sound means that the next dose is ready.
Breathe out fully - do not exhale into the device.
Place the mouthpiece into your mouth and close your lips tightly around it.
Breathe in rapidly and steadily, as deeply as possible; remove the inhaler from your mouth and hold your breath for 10 seconds.
Close the cap after each dose.
Store device in a cool, dry place.
The dose counter displays the number of doses remaining.
Diskhaler
Remove mouthpiece cover and pull tray out from device.
Place disk on wheel with numbers facing up.
Rotate disk by sliding tray out and in.
Lift back of lid until fully upright so that needle pierces both sides of blister.
Keep device level while inhaling dose with a rapid and steady flow.
Breathe in rapidly and steadily, as deeply as possible; hold your breath for 5 to 10 seconds.
Remove device from mouth and exhale outside device.
Brush off any powder remaining within device once every week; store device in cool, dry place.
Diskus
Open the device and slide the lever until it clicks.
Keep device level while inhaling dose.
Breathe in rapidly and steadily, as deeply as possible; hold your breath for 5 to 10 seconds.
Remove device from mouth and exhale outside device; store device in cool, dry place.
Flexhaler
Prime the inhaler: This is done only with the initial dose. Holding the inhaler in the upright position, twist the brown grip as far as it will go in one direction, then twist it all the way back in the other direction. A click will be heard during one of the turns. This step should be repeated to complete the priming of the device.
Load a dose: Holding the inhaler in an upright position, twist the brown grip as far as it will go in one direction, then twist it all the way back in the other direction.

Inhale the dose: Turn away from the inhaler and breathe out. Then place the mouthpiece in your mouth, close your lips, and inhale deeply.
Twisthaler
Hold the inhaler straight up with the pink portion (the base) on the bottom.
Remove the cap while it is in the upright position to make sure you get the right amount of medicine with each dose.
Hold the pink base and twist the cap in a counter-clockwise direction to remove it.
As you lift off the cap, the dose counter on the base will count down by one. This action loads the medicine that you are now ready to inhale.
Make sure the indented arrow located on the white portion (directly above the pink base) is pointing to the dose counter.
Breathe out normally - do not exhale into the device.
Place the mouthpiece into your mouth, with the mouthpiece facing towards you, and close your lips tightly around it.
Inhale dose with a rapid and steady flow while holding the Twisthaler horizontal.
Remove the mouthpiece from your mouth and hold your breath for 5 to 10 seconds (or as long as you comfortably can).
When you exhale, be sure that you are not exhaling into the device.
Immediately replace the cap and turn in a clockwise direction as you gently press down until you hear a click.
Firmly close the Twisthaler to assure that your next dose is properly loaded.
Be sure that the arrow is in line with the dose-counter window.
Store device in a cool, dry place.
The dose counter displays the number of doses remaining. When the unit reads 01, this indicates the last remaining dose. When the counter reads 00, the unit must then be discarded.

Graphic 58951 Version 7.0

Technique for use of soft mist inhalers (SMIs)*

The first time you use a soft mist inhaler, you will need to insert the cartridge.
Keep the cap on the mouthpiece closed. Press the safety catch on the side of the inhaler and pull off the clear plastic base.
Write the discard date on the label. This is 3 months from the date you put in the cartridge.
Push the narrow end of the cartridge into the inhaler.
Push the cartridge against a firm surface or table top to be sure it has gone all the way in. You will know the cartridge is in all the way when it clicks. You will still be able to see a little bit of the cartridge.
Do not remove the cartridge after it has been inserted.
Put the clear base back on. Press until you hear a click.
Do not remove the clear base again.
Prime the inhaler before the first dose.
Hold the inhaler upright with the cap closed. Turn the clear base clockwise (to the right) half a turn until it clicks.
Open the cap by pushing on the small, round opening tab. Then point the inhaler at the floor, away from your face.
Press the dose release button on the side. Check to see if a mist comes out. Close the cap.
If you did **not** see a mist, repeat the priming steps above until you see a mist come out.
After you see a mist come out, repeat these steps 3 more times until you see a total of 4 sprays of medicine.
Your inhaler is now primed and ready for daily use.
If you do not use the inhaler for more than **3 days**, repeat the priming steps 1 time to release 1 spray of medicine.
If you do not use the inhaler for more than **3 weeks**, repeat the priming steps 4 times to release 4 sprays of medicine.
Take a dose of medicine.
Hold the inhaler upright with 1 hand, with the cap closed. You do not need to shake it. Use your other hand to turn the clear base clockwise half a turn in the direction of the arrows. This prepares the dose of medicine.
Open the cap by pushing on the small round opening tab.
Breathe out slowly and fully.
Put the mouthpiece in your mouth, and hold the inhaler horizontally. This means it should point toward the back of your throat.
Close your lips around the inhaler, but do not cover the air vents (holes) on the sides.

Take a slow, deep breath in. As you start to inhale, press the button on the side of the inhaler and inhale the mist.
When your lungs are full, hold your breath for 10 seconds to keep the medicine in your lungs.
Remove inhaler from your mouth and breathe out slowly. Put the cap back on the mouthpiece.
You should clean your inhaler once a week. To do this, wipe the inside and outside of the mouthpiece with a clean, damp cloth.
The inhaler has a dose counter (also called a "dose indicator") on the side. When the arrow is in the red zone, the inhaler is almost empty. When the inhaler is completely empty, the arrow will point to "0," and you will not be able to turn the base of the inhaler. Throw away the inhaler when the counter reads "0" or you reach the discard date, whichever is first. Make sure you always have another inhaler available before you need it.

* Soft mist inhalers are also known as Respimat inhalers.

Graphic 93600 Version 6.0

Asthma action plan

My Asthma Action Plan

Age ≥5 years

Patient Name: _____

Medical Record #: _____

Clinician's Name: _____ DOB: _____

Clinician's Phone #: _____ Completed by: _____ Date: _____

Long-Term Control Medicines	How Much To Take	How Often	Other Instructions
		_____ times per day EVERY DAY!	
		_____ times per day EVERY DAY!	
		_____ times per day EVERY DAY!	
		_____ times per day EVERY DAY!	
Quick-Relief Medicines	**How Much To Take**	**How Often**	**Other Instructions**
		Take ONLY as needed	NOTE: If this medicine is needed frequently, call clinician to consider increasing long-term control medications.

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

GREEN ZONE

I feel *good*.

{My peak flow is in the **GREEN** zone.}

My Personal Best Peak Flow

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:

_____

YELLOW ZONE

I do *not* feel *good*.

{My peak flow is in the **YELLOW** 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
- _____

80% Personal Best

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 one hour, then I should:

- ☐ Increase _____
- ☐ Add _____
- ☐ Call _____

RED ZONE

I feel *awful*.

{My peak flow is in the **RED** zone.}

Warning signs may include one or more of the following:

- It is getting harder and harder to breathe
- Unable to sleep or do usual activities because of trouble breathing

50% Personal Best

Unable

Peak Flow Meter

MEDICAL ALERT! Get help!

- ☐ Take _____ until I get help immediately.
- ☐ Take _____
- ☐ Call _____

Danger! Get help immediately! **Call 9-1-1 if you have trouble walking or talking due to shortness of breath or lips or fingernails are gray or blue.**

Reproduced from: National Heart, Blood, and Lung Institute Expert Panel Report 3 (EPR 3): Guidelines for the Diagnosis and Management of Asthma. NIH Publication no. 08-4051, 2007.

Graphic 55900 Version 4.0

Child asthma action plan

Child Asthma Action Plan
0 to 5 years of age

Patient Name: _____

Medical Record #: _____

Healthcare Provider's Name: _____

DOB: _____

Healthcare Provider's Phone #: _____ Completed by: _____ Date: _____

Long-Term Control Medicines (Use Every Day To Stay Healthy)	How Much To Take	How Often	Other Instructions (such as spacers/masks, nebulizers)
		_____ times per day EVERY DAY!	
		_____ times per day EVERY DAY!	
		_____ times per day EVERY DAY!	
		_____ times per day EVERY DAY!	

Quick-Relief Medicines	How Much To Take	How Often	Other Instructions
		Give ONLY as needed	NOTE: If this medicine is needed often (_____ times per week), call clinician.

GREEN ZONE

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

PREVENT asthma symptoms everyday:
- 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.

☐ _____

☐ _____

YELLOW ZONE

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 could indicate that your child is having trouble breathing may include: difficulty feeding (grunting sounds, poor sucking), changes in sleep patterns, cranky and tired, decreased appetite.

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

☐ Give _____
_____
(include dose and frequency)

If the child is not in the ***Green Zone*** and still has symptoms after one hour then:

☐ Give more _____
_____
(include dose and frequency)

☐ _____
_____
(include dose and frequency)

☐ Call _____

RED ZONE

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 walking/talking/eating/playing.
- Child is drowsy or less alert than normal.

Danger! Get help immediately!

MEDICAL ALERT! Get help!

☐ Take the child to the hospital or call 9-1-1 immediately!

☐ Give more _____ (include dose and frequency) until you get help.

☐ Give _____
(include dose and frequency)

Call 9-1-1 if:
- **The child's skin is sucked in around neck and ribs, or**
- **Lips and/or fingernails are gray or blue, or**
- **Child does not respond to you.**

Reproduced from: National Heart, Blood, and Lung Institute Expert Panel Report 3 (EPR 3): Guidelines for the Diagnosis and Management of Asthma. NIH Publication no. 08-4051, 2007.

Graphic 71958 Version 4.0

Questions to help identify asthma triggers*

Allergen exposures
Do you have asthma symptoms year-round or only certain times of year?
Do you have pets? Or birds? Are they indoors or outdoors most of the time?
Have you seen cockroaches at home/school/work in the past month? How about rodents?
Is there moisture, dampness, moldy odor, or visible mold in your home?¶
For patients who live in dry climates, do you use an evaporative cooler (also known as a swamp cooler)? These coolers are associated with increased humidity and increased mold/dust mites.
Do your asthma symptoms get worse during pollen seasons (eg, tree pollen in early spring in New England) or more humid times of year (suggests molds and dust mites)?
Have you ever had allergy skin or IgE testing? If so, do you have the results?
Irritant exposures
Do you smoke cigarettes? If so, how many/day and how long have you smoked?
Does anyone at home/work/daycare smoke?
Do you smoke cannabis (marijuana), use electronic cigarettes, or vape?
Do you use a wood-burning stove or fireplace at home?
Do you have any unvented/open fire stoves or heaters at home?

Are you exposed regularly to smells or fumes from perfumes, cleaning agents, or sprays?

Work and school

Do you cough, wheeze or need your inhaler more during the week at work/school than on weekends or times away from work/school?

Do your eyes or nose itch or feel irritated at work/school?

Do coworkers or other students have similar symptoms?

Are you exposed to fumes, dusts, or vapors at work? If so, what?

Nasal problems

Do you have seasonal or persistent nasal congestion, runny nose, postnasal drip, or decreased sense of smell?

Are your nasal symptoms worse at home/school/work?

Gastroesophageal reflux

Do you have heartburn (burning sensation in the chest); does food come back up into your mouth; or do you sense/taste sour stomach acid coming up into your throat?

Medications that can worsen asthma

Do you use eye drops? If so, which? Do your asthma symptoms worsen after taking them?

Do you use any medications that contain beta-blockers or ACE inhibitors? Has your asthma worsened since you started taking this medication?

Do you take aspirin or other NSAIDs? Do your asthma symptoms flare when you take them?

Possible sulfite sensitivity[Δ]
Do you have wheezing, coughing, or shortness of breath after eating shrimp, dried fruit, or processed potatoes or after drinking beer or wine?

IgE: immunoglobulin E; ACE: angiotensin-converting enzyme; NSAID: nonsteroidal anti-inflammatory drug.

* These questions are examples and do not represent a standardized assessment or diagnostic instrument. The validity and reliability of these questions have not been assessed.

¶ Higher humidity makes mold and mite exposure more likely. Visible mold suggests significant mold exposure.

Δ Rare issue in children.

Adapted from: National Heart, Blood, and Lung Institute Expert Panel Report 3 (EPR 3): Guidelines for the Diagnosis and Management of Asthma. NIH Publication no. 08-4051, 2007.

Graphic 80507 Version 12.0

Evaluation and management of work aggravated asthma and occupational asthma

Evaluation
Potential for workplace-related symptoms:
Recognized sensitizers (eg, isocyanates, plant or animal products).
Irritants* or physical stimuli (eg, cold/heat, dust, humidity).
Coworkers may have similar symptoms.
Patterns of symptoms (in relation to work exposures):
Improvement occurs during vacations or days off (may take a week or more).
Symptoms may be immediate (<1 hour), delayed (most commonly, 2-8 hours after exposure), or nocturnal.
Initial symptoms may occur after high-level exposure (eg, spill).
Documentation of work-relatedness of airflow limitation:
Serial charting for 2-3 weeks (2 weeks at work and up to 1 week off work, as needed to identify or exclude work-related changes in PEF):
Record when symptoms and exposures occur.
Record when a bronchodilator is used.
Measure and record peak flow (or FEV_1) every 2 hours while awake.
Immunologic tests.
Referral for further confirmatory evaluation (eg, bronchial challenges).
Management
Work-aggravated asthma:
Work with onsite health care providers or managers/supervisors.
Discuss avoidance, ventilation, respiratory protection, tobacco smoke-free environment.
Occupationally induced asthma:
Recommend complete cessation of exposure to initiating agent.

FEV_1: forced expiratory volume in 1 second; PEF: peak expiratory flow.

* Material Safety Data Sheets may be helpful for identifying respiratory irritants, but many sensitizers are not listed.

Reproduced from: National Heart, Blood, and Lung Institute Expert Panel Report 3 (EPR 3): Guidelines for the Diagnosis and

Management of Asthma. NIH Publication no. 08-4051, 2007.

Graphic 69644 Version 1.0

Stepwise asthma management in children 4 to 11 years old

NAEPP* (5 to 11 years old)		GINA (6 to 11 years old)		Our approach (4 to 11 years old)
Asthma symptoms/impact	**Therapy**	**Asthma symptoms**	**Therapy (all steps include SABA as needed)**	**Therapy**
Intermittent: ▪ Daytime symptoms ≤2 days/week ▪ Nocturnal awakenings ≤2/month ▪ No interference with activities ▪ Normal FEV_1 and FEV_1/FVC ▪ Exacerbations ≤1/year	**Step 1** ▪ SABA as needed	▪ Infrequent asthma symptoms (eg, <2 times/month)	**Step 1** Preferred: ▪ Low-dose ICS whenever SABA is used Alternatives: ▪ Daily low-dose ICS	**Step 1** Preferred: ▪ SABA as needed Alternatives: ▪ Low-dose ICS whenever SABA used
Mild persistent: ▪ Daytime symptoms >2 but <7 days/week ▪ Nocturnal awakenings 3 to 4/month ▪ Minor interference with activities ▪ Normal FEV_1 and FEV_1/FVC ▪ Exacerbations ≥2/year	**Step 2**¶ Preferred: ▪ Daily low-dose ICS and SABA as needed Alternative: ▪ Daily LTRA and SABA as needed	▪ Asthma symptoms or need for reliever inhaler ≥2 times/month	**Step 2** Preferred: ▪ Daily low-dose ICS Alternatives: ▪ Daily LTRA or ▪ Low-dose ICS whenever SABA is used	**Step 2** Preferred (includes SABA as needed): ▪ Daily low-dose ICS Alternatives (includes SABA as needed): ▪ Daily LTRA or ▪ Low-dose ICS whenever SABA used
Moderate persistent:	**Step 3**¶ Preferred:	▪ Troublesome asthma	**Step 3** Preferred:	**Step 3** Preferred:

▪ Daily symptoms ▪ Nocturnal awakenings >1/week but not daily ▪ Daily SABA use ▪ Some activity limitation ▪ FEV_1 60 to 80% predicted; FEV_1/FVC below normal ▪ Exacerbations ≥2/year	▪ Daily and as needed low-dose ICS-formoterol Alternative: ▪ Daily medium-dose ICS and as needed SABA or ▪ Daily low-dose ICS-LABA or low-dose ICS plus LTRA and as needed SABA	symptoms most days or ▪ Waking due to asthma ≥1 time/month (also assess risk factors for exacerbations)	▪ Daily low-dose ICS-LABA or ▪ Daily medium-dose ICS Alternative: ▪ Daily low-dose ICS plus LTRA	▪ Daily and as-needed low-dose ICS-formoterol (fast-onset LABA) Alternatives (includes SABA as needed): ▪ Daily low-dose ICS-LABA (slower-onset LABA) or ▪ Daily medium-dose ICS or ▪ Daily low-dose ICS plus LTRA
Severe persistent: ▪ Symptoms throughout the day ▪ Nocturnal awakenings most nights ▪ Need for SABA several times/day ▪ Extreme limitation in activity ▪ FEV_1 <60% predicted; FEV_1/FVC below normal ▪ Exacerbations ≥2/year	**Step 4**[¶] Preferred: ▪ Daily and as needed medium-dose ICS-formoterol Alternative: ▪ Daily medium-dose ICS-LABA and as needed SABA or ▪ Daily medium-dose ICS plus LTRA and as needed SABA	▪ Severe asthma	**Step 4**[¶] Preferred: ▪ Daily medium-dose ICS-LABA or ▪ Daily low-dose ICS plus LTRA Alternatives: ▪ Daily medium-dose ICS-LABA and add-on tiotropium or LTRA	**Step 4** Preferred: ▪ Daily and as needed medium-dose ICS-formoterol (fast-onset LABA) Alternatives (includes SABA as needed): ▪ Daily medium-dose ICS-LABA (slower- onset LABA) or ▪ Daily high-dose ICS or

				▪ Daily medium-dose ICS plus LTRA or ▪ Daily medium-dose ICS-LABA and add-on tiotropium or LTRA
▪ Step-up therapy for severe asthma that is poorly controlled	**Step 5** Preferred: ▪ Daily high-dose ICS-LABA and as needed SABA Alternative: ▪ Daily high-dose ICS plus LTRA and as needed SABA Add-on therapy: ▪ A biologic agent (eg, omalizumab, mepolizumab) is an additional option for patients ≥6 years of age	▪ Step-up therapy for severe asthma that is poorly controlled	**Step 5** Preferred: ▪ Daily medium-dose ICS-LABA and assess for possible high-dose ICS-LABA or add-on therapy (anti-IgE or anti-IL4R) Alternative add-on therapies: ▪ Anti-IL-5R; low-dose OCS only as last resort	**Step 5** Preferred (includes SABA as needed): ▪ Daily medium-dose ICS-LABA and tiotropium (in children ≥6 years of age) or ▪ Daily high-dose ICS-LABA (in children 4 to <6 years of age) Alternatives (includes SABA as needed): ▪ Daily medium-dose ICS-LABA and LTRA or ▪ Daily high-dose ICS-LABA or ▪ Daily high-dose ICS plus LTRA Add-on therapy:

				▪ A biologic agent (eg, omalizumab [anti-IgE], dupilumab [anti-IL-4R], o mepolizumab [anti-IL-5R]) is an additional option for patients ≥6 years of age
	Step 6 Preferred: ▪ Daily high-dose ICS-LABA plus OCS and as needed SABA Alternative: ▪ Daily high-dose ICS plus LTRA and OCS and as needed SABA Add-on therapy: ▪ A biologic agent (eg, omalizumab, mepolizumab) is an additional option for patients ≥6 years of age			**Step 6** ▪ One of the above option plus OCS ▪ A biologic agent (eg, omalizumab, dupilumab, o mepolizumab is an additional option for patients ≥6 years of age

Initial therapies are noted above. A higher level of initial therapy, with concurrent use of OCS in some cases, may be chosen if the patient presents with an acute exacerbation. Treatment may be stepped down if asthma is well controlled for at least 3 months and is stepped up 1 or 2 steps if asthma is not well controlled or is very poorly controlled.

NAEPP: National Asthma Education and Prevention Program; GINA: Global Initiative for Asthma; SABA: short-acting beta agonist; FEV_1: forced expiratory volume in 1 second; FVC: forced vital capacity; ICS:

inhaled corticosteroid (glucocorticoid); LTRA: leukotriene receptor antagonist; LABA: long-acting beta agonist; OCS: oral corticosteroid (glucocorticoid); IgE: immunoglobulin E; IL-5R: interleukin 5 receptor.

* Theophylline, cromolyn, and nedocromil were not included in table even though they were included in NAEPP. They are rarely used due availability of more effective options.

¶ Subcutaneous allergen immunotherapy is suggested as adjunctive treatment in patients with well-controlled asthma and environmental allergies.

References:

1. *National Asthma Education and Prevention Program Coordinating Committee Expert Panel Working Group. 2020 Focused updates to the asthma management guidelines. National Heart, Lung, and Blood Institute, 2007. Available at: https://www.nhlbi.nih.gov/health-topics/all-publications-and-resources/2020-focused-updates-asthma-management-guidelines (Accessed on December 16, 2020).*
2. *Global Initiative for Asthma (GINA). Global Strategy for Asthma Management and Prevention. Available at: www.ginasthma.org (Accessed on October 27, 2022).*

Graphic 127786 Version 6.0

Stepwise asthma management in infants and children <4 years of age with recurrent wheezing*

NAEPP¶ (≤4 years old)		GINA (≤5 years old)		Our approacl (<4 years old
Asthma symptoms/impact	**Therapy (all steps include SABA as needed)**	**Asthma symptoms**	**Therapy (all steps include SABA as needed)**	**Therapy (all steps include SABA as needed)**
Intermittent: ▪ Daytime symptoms ≤2 days/week ▪ No nocturnal awakenings ▪ No interference with activities ▪ Exacerbations treated with OCS ≤1/year	**Step 1** ▪ A short course of a daily ICS beginning at the start of a respiratory tract infection	▪ Infrequent wheezing with viral infections and little to no symptoms between illnesses	**Step 1** Preferred: ▪ SABA as needed Alternative: ▪ Short course of ICS at onset of viral respiratory illness plus SABA as needed	**Step 1** Preferred: ▪ A short course of a daily medium-dose ICS beginning at the start of a respiratory tract infection plus SABA as needed Alternative: ▪ SABA as needed
Mild persistent: ▪ Daytime symptoms >2 but <7 days/week ▪ Nocturnal awakenings 1 to 2/month ▪ Minor interference with activities ▪ Exacerbations treated with OCS ≥2 in 6	**Step 2** Preferred: ▪ Daily low-dose ICS Alternative: ▪ Daily LTRA	▪ Asthma symptoms that require SABA treatment >2 times/week on average for 1 month or ≥3 exacerbations/year or ▪ Treated more often than every 6 to 8 weeks with SABA but asthma diagnosis is in question[Δ]	**Step 2** Preferred: ▪ Daily low-dose ICS Alternatives: ▪ Daily LTRA or ▪ Short course of ICS at onset of viral respiratory illness	**Step 2** Preferred: ▪ Daily low-dose ICS Alternatives: ▪ Daily LTRA or ▪ Intermitter low-dose ICS used whenever a SABA is used

months or ≥4 episodes of wheezing lasting more than a day in a year plus risk factors for persistent asthma				
Moderate persistent: ▪ Daily symptoms ▪ Nocturnal awakenings 3 to 4/month ▪ Daily SABA use ▪ Some activity limitation ▪ Exacerbations treated with OCS ≥2 in 6 months or ≥4 episodes of wheezing lasting more than a day in a year plus risk factors for persistent asthma	**Step 3** ◇ ▪ Daily low-dose ICS-LABA or ▪ Daily low-dose ICS plus LTRA or ▪ Daily medium-dose ICS	▪ Asthma not well controlled on low-dose ICS	**Step 3**§ Preferred: ▪ Double daily low-dose ICS Alternative: ▪ Daily low-dose ICS plus LTRA	**Step 3**§ Preferred: ▪ Daily low-dose ICS-LABA or ▪ Daily low-dose ICS plus LTRA Alternative: ▪ Daily medium-dose ICS
Severe persistent: ▪ Symptoms throughout the day ▪ Nocturnal awakenings >1/week ▪ Need for SABA several times/day ▪ Extreme limitation in activity	**Step 4** ◇ Preferred: ▪ Daily medium-dose ICS-LABA Alternative: ▪ Daily medium-dose ICS plus LTRA	▪ Asthma not well controlled on doubled low-dose ICS	**Step 4**§ Preferred: ▪ Continue doubled daily low-dose ICS and ▪ Refer to asthma specialist for evaluation Alternatives: ▪ Add-on LTRA or	**Step 4** Preferred: ▪ Daily medium-dose ICS-LABA Alternative: ▪ Daily medium-dose ICS plus LTRA

▪ Exacerbations treated with OCS ≥2 in 6 months or ≥4 episodes of wheezing lasting more than a day in a year plus risk factors for persistent asthma			▪ Increase frequency of ICS dosing or ▪ Add intermittent ICS for exacerbations	
▪ Step-up therapy for severe asthma that is poorly controlled	**Step 5** Preferred: ▪ Daily high-dose ICS-LABA Alternative: ▪ Daily high-dose ICS plus LTRA			**Step 5** Preferred: ▪ Daily high-dose ICS-LABA Alternative: ▪ Daily high-dose ICS plus LTRA
	Step 6 Preferred: ▪ Daily high-dose ICS-LABA plus OCS Alternative: ▪ Daily high-dose ICS plus LTRA and OCS			**Step 6** Preferred: ▪ Daily high-dose ICS-LABA plus OCS Alternative: ▪ Daily high-dose ICS plus LTRA and OCS

Initial and step-up therapies are noted above. A higher level of initial therapy, with concurrent use of OCS in some cases, may be chosen if the patient presents with an acute exacerbation. Treatment may be stepped down if asthma is well controlled for at least 3 months and is stepped up 1 or 2 steps if asthma is not well controlled or is very poorly controlled. An alternative to stepping up therapy is to first try one of the alternative options in the same step. Before stepping up therapy, inhaler technique, adherence, and exposure to potential triggers (eg, allergens, tobacco smoke exposures) should be assessed along with evaluating for alternative and/or concomitant diagnoses.

NAEPP: National Asthma Education and Prevention Program; GINA: Global Initiative for Asthma; SABA: short-acting beta agonist; OCS: oral corticosteroid (glucocorticoid); ICS: inhaled corticosteroid (glucocorticoid); LTRA: leukotriene receptor antagonist; LABA: long-acting beta agonist.

* Dosing is reviewed in other UpToDate topics and tables on the management of asthma in children.

¶ Theophylline, nedocromil, and cromolyn are not included in the table even though they were included in NAEPP. They are rarely used due to the availability of more effective options.

Δ In these patients, a 3-month trial of therapy is reasonable and will help confirm or refute the diagnosis of asthma.

◇ For children 4 years of age, refer to steps 3 and 4 in the UpToDate table for stepwise asthma management in children aged 5 to 11.

§ Step-up therapy.

References:

1. *National Asthma Education and Prevention Program Coordinating Committee Expert Panel Working Group. 2020 Focused updates to the asthma management guidelines. National Heart, Lung, and Blood Institute, 2020. Available at: https://www.nhlbi.nih.gov/health-topics/all-publications-and-resources/2020-focused-updates-asthma-management-guidelines (Accessed on December 16, 2020).*
2. *Global Initiative for Asthma (GINA). Global Strategy for Asthma Management and Prevention. Available at: www.ginasthma.org (Accessed on October 27, 2022).*

Graphic 127785 Version 7.0

Assessment of asthma symptom control and risk of exacerbations

A. Level of asthma symptom control

In the past 4 weeks, has the patient had:			Well controlled	Partly controlled	Uncontrolle
Daytime symptoms more than twice/week?	☐ Yes	☐ No	None of these	1 to 2 of these	3 to 4 of these
Any night waking due to asthma?	☐ Yes	☐ No			
SABA reliever* needed more than twice/week?	☐ Yes	☐ No			
Any activity limitation due to asthma?	☐ Yes	☐ No			

B. Risk factors for poor asthma outcomes

Assess risk factors at diagnosis and periodically, at least every 1 to 2 years, particularly for patients experiencing exacerbations.

Measure FEV_1 at start of treatment, after 3 to 6 months of controller treatment to record personal best lung function, then periodically for ongoing risk assessment.

Having uncontrolled asthma symptoms is an important risk factor for exacerbations.

Additional potentially modifiable risk factors for exacerbations, even in patients with few asthma symptoms, include:

- **Medications:** ICS not prescribed; poor adherence; incorrect inhaler technique; high SABA use (with increased mortality if ≥1×200-dose canister/month)¶
- **Comorbidities:** obesity; chronic rhinosinusitis; gastroesophageal reflux disease; confirmed food allergy; anxiety; depression; pregnancy
- **Exposures:** smoking$^{\Delta}$; allergen exposure if sensitized; air pollution
- **Setting:** major socioeconomic problems
- **Lung function:** low FEV_1, especially if <60% predicted; higher reversibility
- **Other tests:** sputum/blood eosinophilia; elevated FE_{NO} in allergic adults on ICS

Other major independent risk factors for flare-ups (exacerbations) include:

- Ever being intubated or in intensive care for asthma
- Having 1 or more severe exacerbations in the last 12 months

Having any o these risk factors increases the patient's risk of exacerbation **even if they have few asthma symptoms**.

Risk factors for developing fixed airflow limitation include preterm birth, low birth weight, and greater infant weight gain; lack of ICS treatment; exposure to tobacco smoke, noxious chemicals, or occupational exposures; low FEV_1; chronic mucus hypersecretion; and sputum or blood eosinophilia

Risk factors for medication side-effects include:

- **Systemic:** frequent OCS; long-term, high dose and/or potent ICS; also taking cytochrome P450 inhibitors

- **Local:** high-dose or potent ICS; poor inhaler technique

Asthma control has two domains: symptom control and risk of future exacerbations. Assess the symptom control domain by patient's recall of previous 4 weeks; assess risk of future exacerbations by the presence of risk factors and by spirometry/or peak flow measures.

FEV_1: forced expiratory volume in one second; ICS: inhaled corticosteroids; SABA: short-acting beta-2 agonist; FE_{NO}: fraction of expired nitric oxide; OCS: oral corticosteroid.

* The threshold of two uses per week as a measure of poor control is only appropriate for SABA relievers. Use of anti-inflammatory relievers (eg low-dose ICS-formoterol or ICS-SABA) provides additional ICS therapy and leads to lower risk of subsequent exacerbation than increased SABA alone. However, average weekly use of anti-inflammatory reliever should still be assessed when reviewing need for or dosing of maintenance ICS.

¶ Current guidelines note that use of ≥3 200-dose SABA canisters/year is also associated with increased exacerbation risk.

Δ Smoking includes e-cigarette exposure.

Graphic 53233 Version 8.0

Assessing asthma control and adjusting therapy in children 5 to 11 years of age

Components of control		Classification of asthma control (5 to 11 years of age)		
		Well controlled	**Not well controlled**	**Very poorly contro**
Impairment	Symptoms	≤2 days/week, but not more than once on each day	>2 days/week or multiple times on ≤2 days/week	Throughout the day
	Nighttime awakenings	≤1 time/month	≥2 times/month	≥2 times/week
	Interference with normal activity	None	Some limitation	Extremely limited
	Short-acting $beta_2$ agonist use for symptom control (not prevention of EIB)	≤2 days/week	>2 days/week	Several times per day
	Lung function			
	▪ FEV_1 or peak flow ▪ FEV_1/FVC	▪ >80% predicted/personal best ▪ >80%	▪ 60 to 80% predicted/personal best ▪ 75 to 80%	▪ <60% predicted/per best ▪ <75%
Risk	**Exacerbations requiring oral systemic glucocorticoids**	**0 to 1/year**	**≥2/year (see footnote)**	
		Consider severity and interval since last exacerbation		
	Reduction in lung growth	Evaluation requires long-term follow-up		
	Treatment-related adverse effects	Medication side effects can vary in intensity from none to very troubleso and worrisome. The level of intensity does not correlate to specific levels control but should be considered in the overall assessment of risk.		
Recommended action for treatment		▪ Maintain current step. ▪ Regular follow-up every 1 to 6 months.	▪ Step up at least 1 step and ▪ Reevaluate in 2 to 6 weeks. ▪ For side effects, consider	▪ Consider short cou oral systemic glucocorticoids, ▪ Step up 1 to 2 steps ▪ Reevaluate in 2 wee

	▪ Consider step down if well controlled for at least 3 months.	alternative treatment options.	▪ For side effects, cor alternative treatme options.

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/caregiver's recall of previous 2 to 4 weeks 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. At present, there are inadequate data to correspond frequencies of exacerbations with different levels of asthma control. In general, more frequent and intense 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 glucocorticoids in the past year may be considered the same as patients who have persistent asthma, even in the absence of impairment levels consistent with persistent asthma.

Before step up in therapy:

- Review adherence to medication, inhaler technique, environmental control, and comorbid conditions.

- If an alternative treatment option was used in a step, discontinue and use the preferred treatment for that step.

EIB: exercise-induced bronchospasm; FEV_1: forced expiratory volume in 1 second; FVC: forced vital capacity; ICU: intensive care unit.

Reproduced from: National Heart, Blood, and Lung Institute Expert Panel Report 3 (EPR 3): Guidelines for the Diagnosis and Management of Asthma. NIH Publication no. 08-4051, 2007.

Graphic 64986 Version 10.0

Assessing asthma control and adjusting therapy in children 0 to 4 years of age

Components of control		Classification of asthma control (0 to 4 years of age)		
		Well controlled	**Not well controlled**	**Very poorly controlled**
Impairment	Symptoms	≤2 days/week	>2 days/week	Throughout the day
	Nighttime awakenings	≤1 time/month	>1 time/month	>1 time/week
	Interference with normal activity	None	Some limitation	Extremely limited
	Short-acting $beta_2$ agonist use for symptom control (not prevention of EIB)	≤2 days/week	>2 days/week	Several times per day
Risk	**Exacerbations requiring oral systemic glucocorticoids**	**0 to 1/year**	**2 to 3/year**	**>3/year**
	Treatment-related adverse effects	Medication side effects can vary in intensity from none to very troublesome and worrisome. The level of intensity does not correlate to specific levels of control but should be considered in the overall assessment of risk.		
Recommended action for treatment		▪ Maintain current treatment. ▪ Regular follow-ups every 1 to 6 months. ▪ Consider step down if well controlled for at least 3 months.	▪ Step up (1 step) and ▪ Reevaluate in 2 to 6 weeks. ▪ If no clear benefit in 4 to 6 weeks, consider alternative diagnoses or adjusting therapy. ▪ For side effects, consider alternative treatment options.	▪ Consider short course of oral systemic glucocorticoids, ▪ Step up (1 to 2 steps) and ▪ Reevaluate in 2 weeks. ▪ If no clear benefi in 4 to 6 weeks, consider alternative diagnoses or adjusting therapy ▪ For side effects, consider alternative

			treatment options.

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 caregiver's recall of previous 2 to 4 weeks. 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. There are inadequate data to correspond frequencies of exacerbations with different levels of asthma control. In general, more frequent and intense 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 glucocorticoids 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.

Before step up in therapy:

- Review adherence to medication, inhaler technique, and environmental control.

- If an alternative treatment option was used in a step, discontinue and use the preferred treatment for that step.

EIB: exercise-induced bronchospasm; ICU: intensive care unit.

Reproduced from: National Heart, Blood, and Lung Institute Expert Panel Report 3 (EPR 3): Guidelines for the Diagnosis and Management of Asthma. NIH Publication no. 08-4051, 2007.

Graphic 78322 Version 9.0

European Respiratory Society/American Thoracic Society definition of severe asthma for patients aged ≥6 years*

The definition of severe asthma requires that one or both of the following levels of treatment for the previous year has been needed to prevent asthma from becoming uncontrolled or asthma that remains uncontrolled despite this level of treatment:

- Treatment with guidelines suggested medications for GINA steps 4-5 asthma (high dose inhaled glucocorticoid* and long-acting beta agonist [LABA] or leukotriene modifier/theophylline) for the previous year
- Treatment with systemic glucocorticoid for ≥50% of the year

Uncontrolled asthma is defined as at least one of the following:

- Poor symptom control: ACQ consistently ≥1.5, ACT <20 (or "not well controlled" by NAEPP/GINA guidelines)
- Frequent severe exacerbations: two or more bursts of systemic glucocorticoids (three or more days each) in the previous year
- History of serious exacerbation: at least one hospitalization, intensive care unit stay, or mechanical ventilation in the previous year
- Airflow limitation: after appropriate bronchodilator withhold FEV_1 <80% predicted (in the face of reduced FEV_1/FVC defined as less than the lower limit of normal)

The ERS/ATS definition of high doses of various inhaled glucocorticoids in relation to patient age (in mcg/day):

	Age 6 to 12 years	Age >12 years
Beclomethasone	≥320 (HFA MDI)	≥1000 (HFA MDI)
Budesonide	≥800* (MDI or DPI)	≥1600[¶] (MDI or DPI)
Ciclesonide	≥160 (HFA MDI)	≥320 (HFA MDI)
Fluticasone propionate	≥500[Δ] (HFA MDI or DPI)	≥1000[◇] (HFA MDI or DPI)
Mometasone	≥500[§] (DPI)	≥800[¥] (DPI)

Designation of high doses is provided from manufacturers' recommendations where possible. Equivalent high doses may be expressed differently between countries and some products (eg, beclomethasone) are available in multiple formulations with different dosing recommendations. Medication inserts should be carefully reviewed by the clinician for the equivalent high daily dosage.

ACQ: Asthma Control Questionnaire; ACT: Asthma Control Test; DPI: dry powder inhaler; GINA: Global Initiative for Asthma; HFA: hydrofluoroalkane; LABA: long-acting beta-agonists; MDI: metered-dose

inhaler; NAEPP: National Asthma Education Prevention Program.

* ≥720 mcg/day of US labeled budesonide DPI.

¶ ≥1440 mcg/day of US labeled budesonide DPI.

Δ ≥440 mcg/day of US labeled fluticasone HFA MDI.

◇ ≥880 mcg/day of US labeled fluticasone HFA MDI.

§ ≥550 mcg/day of US labeled mometasone DPI.

¥ ≥880 mcg/day of US labeled mometasone DPI.

Graphic 68983 Version 7.0

Estimated comparative daily doses for inhaled glucocorticoids in adolescents ≥12 years and adults

Drug	Low dose (total daily dose)	Medium dose (total daily dose)	High dose (total daily dose)*
Beclomethasone HFA (Qvar RediHaler product available in United States) Administer as 2 divided doses	80 to 160 mcg	>160 to 320 mcg	>320 to 640 mcg
40 mcg per actuation	2 or 4 inhalations	¶	¶
80 mcg per actuation	2 inhalations	4 inhalations	6 or 8 inhalations
Beclomethasone HFA[Δ] (Qvar product available in Canada, Europe, and elsewhere) Administer as 2 divided doses	100 to 200 mcg	>200 to 400 mcg	>400 to 800 mcg
50 mcg per actuation	2 to 4 inhalations	¶	¶
100 mcg per actuation	2 inhalations	4 inhalations	6 or 8 inhalations
Budesonide DPI (Pulmicort Flexhaler product available in United States) Administer as 2 divided doses	180 to 360 mcg	>360 to 720 mcg	>720 to 1440 mcg
90 mcg per actuation	2 or 4 inhalations	¶	¶
180 mcg per actuation	2 inhalations	4 inhalations	6 or 8 inhalations
Budesonide DPI[Δ] (Pulmicort Turbuhaler or Turbohaler product available in Canada, Europe, and elsewhere) Administer low doses (ie, ≤400 mcg/day) once daily; administer higher doses (ie, >400 mcg/day) as 2 to 4 divided doses	200 to 400 mcg	>400 to 800 mcg	>800 to 2400 mcg
100 mcg per actuation	2 to 4 inhalations	¶	¶
200 mcg per actuation	1 to 2 inhalations	3 to 4 inhalations	¶
400 mcg per actuation	1 inhalation	2 inhalations	3 to 6 inhalations

Ciclesonide HFA (Alvesco product available in United States, Europe, and elsewhere) United States: Administer as 2 divided doses Australia, Europe, and elsewhere: Administer lower doses (ie, 160 to 320 mcg/day) once daily; administer 640 mcg dose as 2 divided doses	160 mcg	320 mcg	640 mcg
80 mcg per actuation	2 inhalations	4 inhalations	¶
160 mcg per actuation	◇	2 inhalations	4 inhalations
Ciclesonide HFA[Δ] (Alvesco product available in Canada) Administer lower doses (eg, 100 to 400 mcg) once daily; administer 800 mcg dose as 2 divided doses	100 to 200 mcg	>200 to 400 mcg	>400 to 800 mcg
100 mcg per actuation	1 to 2 inhalations	3 to 4 inhalations	¶
200 mcg per actuation	1 inhalation	2 inhalations	3 to 4 inhalations
Fluticasone propionate HFA (Flovent HFA product available in United States) Administer as 2 divided doses	176 to 220 mcg	>220 to 440 mcg	>440 to 1760 mcg
44 mcg per actuation	4 inhalations	¶	¶
110 mcg per actuation	2 inhalations	4 inhalations	¶
220 mcg per actuation	◇	2 inhalations	4 to 8 inhalations
Fluticasone propionate HFA[Δ] (Flovent HFA product available in Canada; Flixotide Evohaler product available in Europe and elsewhere) Administer as 2 divided doses	100 to 250 mcg	>250 to 500 mcg	>500 to 2000 mcg
50 mcg per actuation	2 to 4 inhalations	¶	¶
125 mcg per actuation	2 inhalations	4 inhalations	¶
250 mcg per actuation	◇	2 inhalations	4 to 8 inhalations
Fluticasone propionate DPI (Flovent Diskus product available in United States and Canada; Flixotide	100 to 250 mcg	>250 to 500 mcg	>500 to 2000 mcg

Accuhaler product available in Europe and elsewhere) Administer as 2 divided doses			
50 mcg per actuation	2 to 4 inhalations	¶	¶
100 mcg per actuation	2 inhalations	4 inhalations	¶
250 mcg per actuation	◇	2 inhalations	4 to 8 inhalations
500 mcg per actuation (strength not available in United States)	◇	◇	2 or 4 inhalations
Fluticasone propionate DPI (Armonair Digihaler product available in United States; Aermony Respiclick product available in Canada) Administer as 2 divided doses	110 mcg	226 mcg	464 mcg
55 mcg per actuation	2 inhalations	¶	¶
113 mcg per actuation	◇	2 inhalations	¶
232 mcg per actuation	◇	◇	2 inhalations
Fluticasone furoate DPI (Arnuity Ellipta product available in United States, Canada, Australia, and elsewhere, but not available in Europe or UK) Administer once daily **NOTE:** Inhaled fluticasone furoate has a greater anti-inflammatory potency per microgram than fluticasone propionate inhalers. Thus, fluticasone furoate is administered at a lower daily dose and used only once daily.	50 mcg (by use of pediatric DPI, which is off-label in adolescents and adults)	100 mcg	200 mcg
50 mcg per actuation	1 inhalation	¶	¶
100 mcg per actuation	◇	1 inhalation	2 inhalations
200 mcg per actuation	◇	◇	1 inhalation
Mometasone DPI (Asmanex Twisthaler product available in United States) May administer lower doses (ie, 220 to 440 mcg/day) once daily; administer 880 mcg dose as 2 divided doses	220 mcg	>220 to 440 mcg	>440 to 880 mcg

110 mcg per actuation	2 inhalations	¶	¶
220 mcg per actuation	1 inhalation	2 inhalations	4 inhalations
Mometasone HFA (Asmanex HFA product available in United States) Administer as 2 divided doses	200 mcg	>200 to 400 mcg	>400 to 800 mcg
100 mcg per actuation	2 inhalations	4 inhalations	¶
200 mcg per actuation	◇	2 inhalations	4 inhalations
Mometasone DPIΔ (Asmanex Twisthaler product available in Canada, Europe, and elsewhere) May administer lower doses (ie, 200 to 400 mcg/day) once daily; administer 800 mcg dose as 2 divided doses	200 mcg	>200 to 400 mcg	>400 to 800 mcg
200 mcg per actuation	1 inhalation	2 inhalations	¶
400 mcg per actuation	◇	1 inhalation	2 inhalations

- **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. The stepwise approach to therapy emphasizes that once control of asthma is achieved, the dose of medication should be carefully titrated to the minimum dose required to maintain control, thus reducing the potential for adverse effects.
- Suggested total daily doses for low, medium, and high dose inhaled glucocorticoid regimens are based on daily doses recommended by Global Initiative for Asthma (GINA), National Asthma Education and Prevention Program (NAEPP), and/or product labeling[1-5]. This is not a table of equivalence.
- Depending on the specific product, total daily doses are administered once or divided and given twice daily. Refer to local product information or a clinical drug reference (eg, Lexicomp).
- Some doses are outside the approved product information recommendations.

DPI: dry powder inhaler; HFA: hydrofluoroalkane propellant metered dose inhaler.

* Evidence for additional improvement with dose increases >1000 mcg/day is limited.

¶ Select alternate preparation with higher mcg/actuation to improve convenience.

Δ Products shaded in light gray color are not available in the United States but are available widely elsewhere.

◇ Select preparation with fewer mcg/actuation.

Data from:

1. *Global Initiative for Asthma (GINA); Global Strategy for Asthma Management and Prevention; 2021. Available at www.ginasthma.org.*
2. *National Heart, Blood, and Lung Institute Expert Panel Report 3 (EPR 3): Guidelines for the Diagnosis and Management of Asthma; 2007. NIH Publication 08-4051 available at http://www.nhlbi.nih.gov/health-pro/guidelines/current/asthma-guidelines/full-report and pro.*
3. *US Food & Drug Administration (FDA) approved product information. US National Library of Medicine. (Available online at www.dailymed.nlm.nih.gov/dailymed/index.cfm.)*
4. *Health Canada-approved product monograph. Health Canada. (Available online at https://health-products.canada.ca/dpd-bdpp/index-eng.jsp.)*
5. *European Medicines Agency (EMA) summary of product characteristics. European Medicines Agency. (Available online at www.ema.europa.eu/en/medicines.)*

Graphic 78011 Version 17.0

Usual doses of combined inhaled glucocorticoids and bronchodilators

Medication	Low dose	Medium dose	High dose
ICS-SABA combination			
Budesonide-albuterol HFA (Brand name: Airsupra)*			
NOTE: Not used for maintenance therapy. Acute symptom relief: Budesonide-albuterol (80 mcg/90 mcg) 2 inhalations as needed (usual maximum 12 inhalations/day).			
ICS-LABA combinations			
Beclomethasone [beclometasone]-formoterol DPI or HFA (Not available in United States or Canada, but available elsewhere [sample brand names: Formodual, Fostair, Foster])¶ Δ			
100 mcg/6 mcg	1 inhalation twice a day	2 inhalations twice a day	
200 mcg/6 mcg			2 inhalations twice a da
Budesonide-formoterol HFA (Brand names: Symbicort, Breyna)¶			
80 mcg/4.5 mcg	2 inhalations twice a day		
160 mcg/4.5 mcg		2 inhalations twice a day	
Fluticasone furoate-vilanterol DPI (Brand name: Breo Ellipta)Δ			
NOTE: Inhaled fluticasone furoate has a greater anti-inflammatory potency per microgram than fluticasone propionate inhalers. Thus, fluticasone furoate is administered at a lower daily dose and use only **once** daily.			
50 mcg/25 mcg◇	1 inhalation once daily		
100 mcg/25 mcg		1 inhalation once daily	
200 mcg/25 mcg			1 inhalation once daily
Fluticasone propionate-formoterol MDI (Not available in United States or Canada, but available elsewhere [sample brand name: Flutiform])			
50 mcg/5 mcg	2 inhalations twice daily		
125 mcg/5 mcg		2 inhalations twice daily	
250 mcg/10 mcg			2 inhalations twice daily
Fluticasone propionate-salmeterol DPI (Brand names: Advair Diskus, Wixela Inhub)Δ			
100 mcg/50 mcg	1 inhalation twice a day		
250 mcg/50 mcg		1 inhalation twice a day	
500 mcg/50 mcg			1 inhalation twice a day
Fluticasone propionate-salmeterol HFA (Brand name: Advair HFA)			

45 mcg/21 mcg	2 inhalations twice a day		
115 mcg/21 mcg		2 inhalations twice a day	
230 mcg/21 mcg			2 inhalations twice a da
Fluticasone propionate-salmeterol DPI (Brand names: AirDuo RespiClick, AirDuo Digihaler)[Δ §]			
55 mcg/14 mcg	1 inhalation twice a day		
113 mcg/14 mcg	1 inhalation twice a day	1 inhalation twice a day	
232 mcg/14 mcg			1 inhalation twice a day
Mometasone-formoterol HFA (Brand name: Dulera)			
100 mcg/5 mcg		2 inhalations twice a day	
200 mcg/5 mcg			2 inhalations twice a da
Mometasone-indacaterol DPI (Brand name: Atectura Breezhaler; available in Canada)[Δ]			
80 mcg/150 mcg	1 inhalation (capsule) once a day		
160 mcg/150 mcg		1 inhalation (capsule) once a day	
320 mcg/150 mcg			1 inhalation (capsule) once a day
ICS-LAMA-LABA combinations[¥]			
Fluticasone furoate-umeclidinium-vilanterol DPI (Brand name: Trelegy Ellipta)[Δ]			
100 mcg/62.5 mcg/25 mcg		1 inhalation once daily	
200 mcg/62.5 mcg/25 mcg			1 inhalation once daily
Mometasone-glycopyrrolate (glycopyrronium)-indacaterol DPI (Brand name: Enerzair Breezhaler; available in Canada)*[Δ]			
160 mcg/50 mcg/150 mcg			1 inhalation (capsule) once a day

Do not exceed the maximum number of inhalations/puffs per day listed in the table due to the risk of toxicity from an excess dose of long-acting beta-agonist (ie, salmeterol, formoterol, or vilanterol). Brand names and dose per puff or per inhalation of commercially available fixed dose combinations are according to United States prescribing information, unless otherwise noted. Consult local product information before use.

ICS: inhaled glucocorticoid (inhaled corticosteroid); SABA: short-acting beta-agonist; LABA: long-acting beta-agonist; LAMA: long-acting muscarinic antagonist; HFA: metered dose inhaler with hydrofluoroalkane propellant; DPI: dry powder inhaler; SMI: soft mist inhaler.

* Not approved for use in patients <18 years old.

¶ When using ICS-formoterol as reliever, use one to two inhalations as needed. Maximum daily dose of maintenance and rescue is 12 inhalations.

Δ DPI contains lactose which may have small amounts of milk protein.

◇ Fluticasone furoate-vilanterol 50 mcg/25 mcg DPI is approved for use in patients 5 to 11 years old; use in adolescents and adults is off-label.

§ In AirDuo inhalers, the daily dose of salmeterol is approximately one-fourth of the dose in Advair, and the daily dose of fluticasone is approximately one-half that of the comparable low-, medium-, and high-dose strengths of Advair.

¥ Alternatively, tiotropium SMI (Brand name: Spiriva Respimat) can be used with an ICS or ICS-LABA inhaler. The dose in asthma is two inhalations (1.25 mcg/inhalation) once daily.

Reference: Global Initiative for Asthma (GINA). Global strategy for asthma management and prevention. https://ginasthma.org/wp-content/uploads/2023/05/GINA-2023-Full-Report-2023-WMS.pdf. Updated 2023 (Accessed on June 13, 2023).

Graphic 68143 Version 26.0

Usual doses for long-term asthma controller medications other than inhaled glucocorticoids in children*

Medication	Dose form	0 to 4 years	5 to 11 years	Comments
Leukotriene receptor antagonists (LTRAs)¶				
Montelukast	4 mg or 5 mg chewable tablet 4 mg granule packets	4 mg once daily at bedtime (1 to 5 years of age).	5 mg once daily at bedtime (6 to 14 years of age).	When LTRA treatment is indicated, montelukast is preferred.
Zafirlukast	10 mg tablet	Safety and efficacy not established.	10 mg twice per day on empty stomach.	Zafirlukast has potential drug interactions and a small risk of hepatotoxicity. Food decreases bioavailability of zafirlukast; take at least 1 hour before or 2 hours after meals.
Combined inhaled glucocorticoids and long-acting beta agonists (LABAs)Δ				
Fluticasone-salmeterol	DPI 100 mcg/50 mcg	Safety and efficacy not established.	1 inhalation twice per day.	Most children <4 years of age cannot provide sufficient inspiratory flow for adequate lung delivery of DPI. Do not exceed dose shown.
	MDI 45 mcg/21 mcg		2 puffs twice per day.	
Budesonide-formoterol	HFA MDI 80 mcg/4.5 mcg	Safety and efficacy not established.	1 to 2 puffs twice per day.	Onset of formoterol is similar to albuterol. There have been no clinical trials in children ≤4 years of age. Do not exceed dose shown.
Mometasone-formoterol	HFA MDI 50 mcg/5 mcg	Safety and efficacy not established.	2 puffs twice per day.	
Systemic glucocorticoids				
Methylprednisolone	For detail, refer to Lexicomp drug-specific	0.25 to 2 mg/kg orally per day or every other day given in the	0.25 to 2 mg/kg orally per day or every other day given in the	**(Applies to all 3 glucocorticoids)**

	monographs included with UpToDate	morning. Titrate to the lowest acceptable dose that maintains control.	morning. Titrate to the lowest acceptable dose that maintains control.	Due to their toxic effects, systemic glucocorticoids should be used only rarely for long-term control of asthma (ie, in those few patients with poorly controlled severe persistent asthma despite compliance with maximized ICS and other pharmacologic and preventive therapies). Refer to UpToDate topics on the treatment of persistent asthma in children. The use and dosing of systemic glucocorticoids for the treatment of acute asthma exacerbations is reviewed elsewhere. Refer to UpToDate topics on acute asthma exacerbations in children in the emergency department and inpatient management.
Prednisolone				
Prednisone				
Long-acting anticholinergic agents				
Tiotropium	Soft-mist inhaler 1.25 mcg/actuation	Safety and efficacy not established.	2 inhalations once daily. (Off-label use: 2 inhalations of 2.5 mcg/actuation dose once daily.)	Inhaler is used without a spacer/valved holding chamber. There have been no clinical trials in children ≤4 years of age.
Chromones				
Cromolyn sodium (sodium cromoglycate)	5 mg/puff CFC free MDI (not available in the United States)◇	Safety and efficacy not established	2 puffs 4 times per day.	Less effective than ICS in children. Add-on to ICS is not recommended. Refer to UpToDate topics on the treatment of persistent asthma in children. 4- to 6-week trial may be needed to determine
	20 mg/ampule	20 mg 4 times per day.	20 mg 4 times per day.	

	solution for nebulization	Safety and efficacy not established in children aged <2 years.		maximum benefit. May cause bronchospasm. Premedication with bronchodilator may be needed. Use of spacer device may substantially decrease amount of drug delivered Once control is achieved, the frequency of dosing may be reduced.
Nedocromil	2 mg/puff CFC free inhaler (not available in the United States)◇	Safety and efficacy not established in children aged <6 years.	2 puffs 4 times per day.	
Biologic agents: Refer to separate UpToDate table and topics on biologic therapy for asthma, including omalizumab (anti-IgE) and mepolizumab (anti-IL-5)				
Methylxanthines				
Theophylline	Liquids, sustained-release tablets and capsules	Starting dose for patients without risk factors for decreased theophylline clearance approximately 10 mg/kg per day (initial maximum 300 mg per day). Usual maximum following titration: ▪ <1 year of age: 0.2 × (age in weeks) + 5 = dose in mg/kg per day ▪ ≥1 year of age: 16 mg/kg per day (maximum	Starting dose for patients without risk factors for decreased theophylline clearance approximately 10 mg/kg/day (initial maximum 300 mg per day). Usual maximum following titration: ▪ 16 mg/kg/day (maximum 600 mg per day)	Due to risk of toxic effects, requirement of frequent serum concentration monitoring, and significant drug-drug interactions, theophylline is infrequently used. Monitoring and dose adjustment is required to maintain peak serum levels of 5 to 15 mcg/mL at steady-state. For additional information, including approach to dose adjustment, refer to UpToDate topics on theophylline use in asthma.

		600 mg per day)		

LTRA: leukotriene receptor antagonist; LABA: long-acting beta agonist; DPI: dry-powder inhaler; MDI: metered-dose inhaler; HFA: hydrofluoroalkane (inhaler propellant); ICS: inhaled glucocorticoid; CFC: chlorofluorocarbon; IgE: immunoglobulin E; IL: interleukin.

* Doses are provided for those products that have been approved by the US Food and Drug Administration or have sufficient clinical trial safety and efficacy data in the appropriate age ranges to support their use.

¶ Zileuton is available in the United States and some other countries. Its use is not recommended in children.

Δ LABAs should only be used in combination products with inhaled glucocorticoids. Other ICS-LABA combination products are available. Some ICS-LABA combination inhalers may be approved for use in children in countries other than the United States.

◇ Chromone DPI and MDI inhalers with different strengths than those listed in this table are available in some countries other than the United States. Consult local product information.

Data from:

1. *National Heart, Blood, and Lung Institute Expert Panel Report 3 (EPR 3): Guidelines for the Diagnosis and Management of Asthma. NIH Publication no. 08-4051, 2007.*
2. *Global Initiative for Asthma (GINA). Global Strategy for Asthma Management and Prevention. Updated 2012. Available at www.ginasthma.org.*

Graphic 57761 Version 10.0

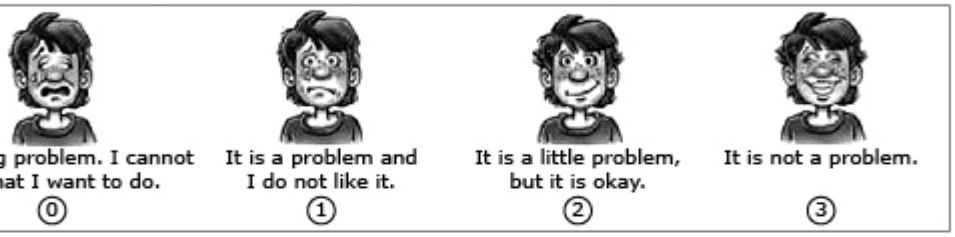
Childhood Asthma Control Test for children aged 4 to 11 years

Have your child complete these questions.

1. How is your asthma today? **SCORE**

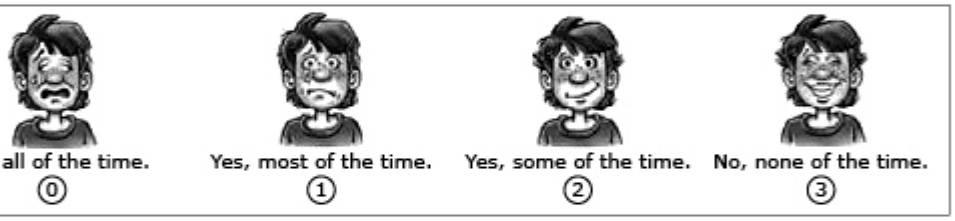
☐

2. How much of a problem is your asthma when you run, exercise, or play sports?



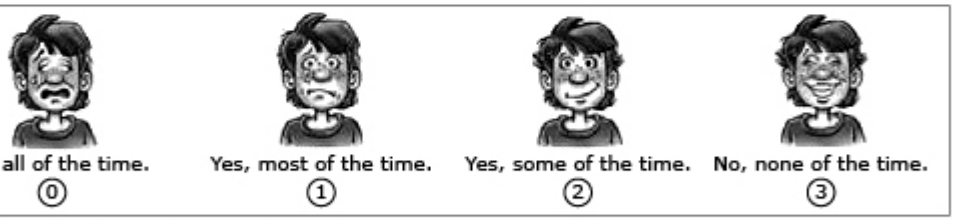
☐

3. Do you cough because of your asthma?



☐

4. Do you wake up during the night because of your asthma?



☐

Please complete the following questions on your own

5. During the *last four weeks*, how many days did your child have any daytime asthma symptoms?

5	4	3	2	1	0
Not at all	1 to 3 days	4 to 10 days	11 to 18 days	19 to 24 days	Everyday

☐

6. During the *last four weeks*, how many days did your child wheeze during the day because of asthma?

5	4	3	2	1	0
Not at all	1 to 3 days	4 to 10 days	11 to 18 days	19 to 24 days	Everyday

☐

7. During the *last four weeks*, how many days did your child wake up during the night because of asthma?

5	4	3	2	1	0
Not at all	1 to 3 days	4 to 10 days	11 to 18 days	19 to 24 days	Everyday

☐

TOTAL ☐

Graphic 81872 Version 6.0

Asthma Control Test®

This survey was designed to help you describe your asthma and how your asthma affects how you feel and what you are able to do. To complete it, please mark an X in the box that best describes your answer.

1. In the **past 4 weeks**, how much of the time did your asthma keep you from getting as much done at work or at home?

All of the time	Most of the time	Some of the time	A little of the time	None of the time
☐ 1	☐ 2	☐ 3	☐ 4	☐ 5

2. During the **past 4 weeks**, how often have you had shortness of breath?

More than once a day	Once a day	3 to 6 times a week	Once or twice a week	Not at all
☐ 1	☐ 2	☐ 3	☐ 4	☐ 5

3. In the **past 4 weeks**, how often did your asthma symptoms (wheezing, coughing, shortness of breath, chest tightness or pain) wake you up at night or earlier than usual in the morning?

4 or more nights a week	2 to 3 nights a week	Once a week	Once or twice	Not at all
☐ 1	☐ 2	☐ 3	☐ 4	☐ 5

4. In the **past 4 weeks**, how often have you used your rescue inhaler or nebulizer medication (such as Albuterol, Ventolin®, Proventil®, Maxair®, or Primatene Mist®)?

3 or more times per day	1 or 2 times per day	2 or 3 times per week	Once a week or less	Not at all
☐ 1	☐ 2	☐ 3	☐ 4	☐ 5

5. How would you rate your asthma control during the **past 4 weeks**?

Not controlled at all	Poorly controlled	Somewhat controlled	Well controlled	Completey controlled
☐ 1	☐ 2	☐ 3	☐ 4	☐ 5

For information on the interpretation and scoring of the Asthma Control Test® (ACT®)*, visit https://www.asthmacontroltest.com.

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* The ACT is a validated instrument for assessment of asthma control. The scores range from 5 (poor control of asthma) to 25 (complete control of asthma), with higher scores reflecting greater asthma control. An ACT score >19 indicates well-controlled asthma.

Graphic 50620 Version 4.0

Predicted peak expiratory flow (PEF; liters/minute) for females age 20 to 70 years

Age (years)	Height				
	55 inches/140 cm	60 inches/152 cm	65 inches/165 cm	70 inches/178 cm	75 inches/190 cm
20	333	372	418	468	517
25	340	379	425	475	524
30	344	383	429	479	528
35	344	383	430	479	529
40	342	381	427	477	526
45	336	376	422	471	521
50	328	367	413	463	512
55	316	323	401	451	501
60	301	341	387	436	486
65	283	323	369	419	468
70	263	302	348	398	447

For patients who do not know their personal best PEF, this table can help estimate an expected "personal best." This table uses a prediction equation for White females age 20 to 70 years. Refer to UpToDate calculator for values for additional age, height, and race/ethnicity parameters.

Reference:

1. *Hankinson JL, Odencrantz JR, Fedan KB. Spirometric reference values from a sample of the general U.S. population. Am J Respir Crit Care Med. 1999; 159(1):179.*

Graphic 62839 Version 10.0

Predicted peak expiratory flow (PEF; liters/minute) for males age 20 to 70 years

Age (years)	Height				
	60 inches/152 cm	65 inches/165 cm	70 inches/178 cm	75 inches/191 cm	80 inches/203 cm
20	477	539	606	678	748
25	484	546	613	685	756
30	488	550	616	688	759
35	487	549	616	688	758
40	483	545	611	683	754
45	474	536	603	675	746
50	462	436	591	663	733
55	446	508	575	646	717
60	426	488	554	626	697
65	402	464	530	602	673
70	374	436	503	574	645

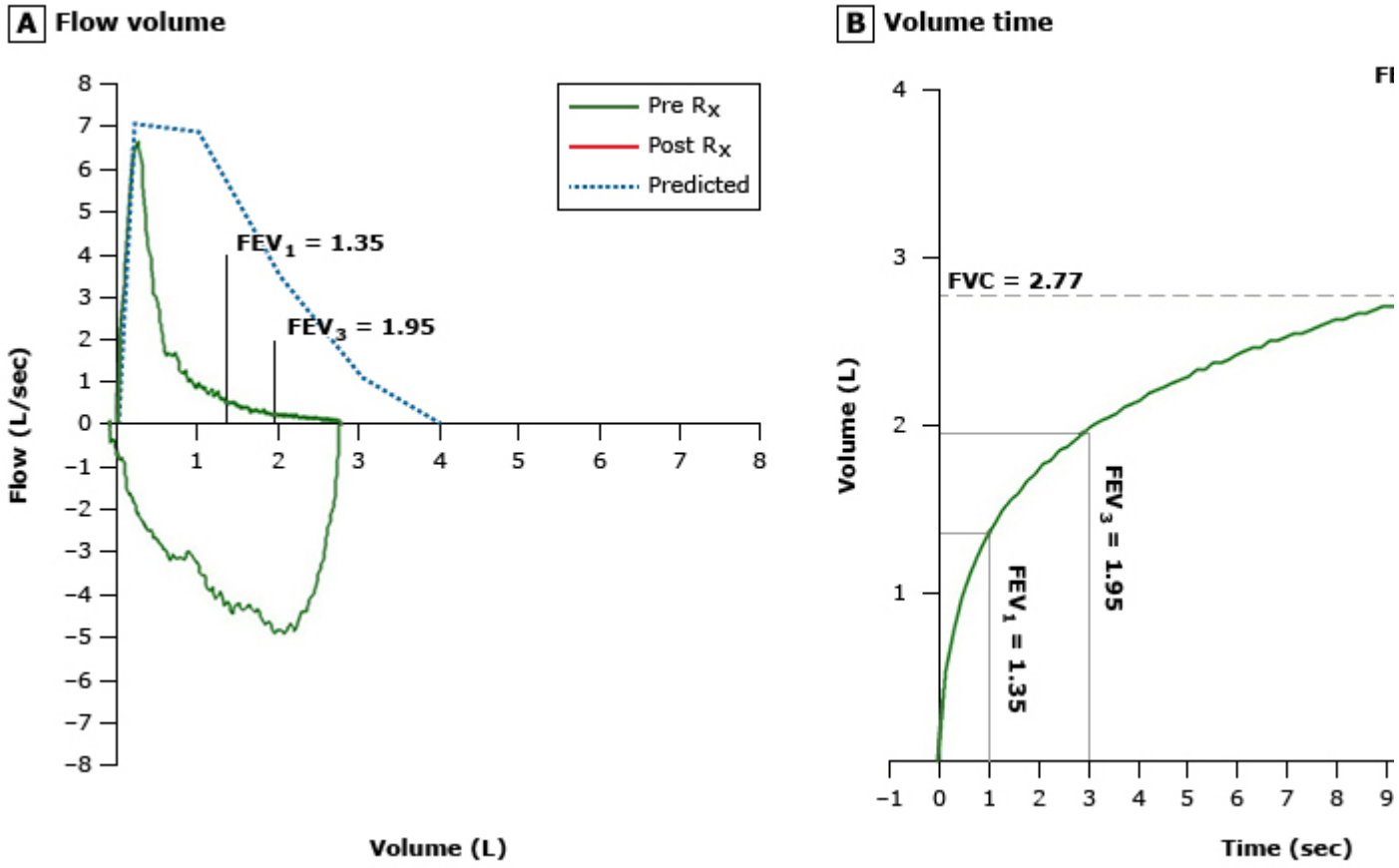
For patients who do not know their personal best PEF, this table can help estimate an expected "personal best." This table uses a prediction equation for White males, age 20 to 70 years. Refer to UpToDate calculator for values for additional age, height, and race/ethnicity parameters.

Reference:

1. *Hankinson JL, Odencrantz JR, Fedan KB. Spirometric reference values from a sample of the general U.S. population. Am J Respir Crit Care Med. 1999; 159(1):179.*

Graphic 57257 Version 10.0

Example of impaired FEV_1 with preserved peak flow



Although often correlated, peak flow and FEV_1 may be uncoupled, with peak flow severely underestimating asthma severity. Above are flow-volume and volume-time loops in a patient with preserved peak flow (peak of flow-volume loop) but profound obstruction (FEV_1/FVC <0.5, FEV_1 44% predicted, plateau FVC not achieved after 10 seconds).

FEV_1: forced expiratory volume in one second; FEV_3: forced expiratory volume in three seconds; FVC: forced vital capacity; FET: forced expiratory time.

Courtesy of Christopher H Fanta, MD.

Graphic 141036 Version 1.0