Acute exacerbations of asthma in adults: Home and office management

AUTHOR: Katherine N Cahill, MD, FAAAAI
SECTION EDITOR: Anne E Dixon, BM, BCh
DEPUTY EDITOR: Paul Dieffenbach, MD

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INTRODUCTION

Acute asthma exacerbations are episodes of worsening asthma symptoms and lung function; they can be the presenting manifestation of asthma or occur in patients with a known asthma diagnosis in response to a "trigger" such as viral upper respiratory infection, allergen, air pollution or other irritant exposure, lack of adherence to controller medication, or an unknown stimulus [1-3]. The best strategy for management of acute exacerbations of asthma is early recognition and intervention, before attacks become severe and potentially life-threatening. Detailed investigations into the circumstances surrounding fatal asthma have frequently revealed failures on the part of both patients and clinicians to recognize the severity of the disease and intensify treatment appropriately [1,2].

The management of acute asthma exacerbations will be presented here. An overview of asthma management, emergency department and inpatient management of asthma exacerbations in adults, identification of risk factors for fatal asthma and asthma triggers, and the use of mechanical ventilation in severe exacerbations of asthma are discussed separately. (See "An overview of asthma management" and "Acute exacerbations of asthma in adults: Emergency department and inpatient management" and "Identifying patients at risk for fatal asthma" and "Trigger control to enhance asthma management" and "Invasive mechanical ventilation in adults with acute exacerbations of asthma".)

ALGORITHMS FOR ASSESSMENT AND TREATMENT AT HOME AND IN THE OFFICE

Our approaches to the management of acute exacerbations of asthma at home and in the office, which are consistent with international guidelines, are outlined in the algorithms (algorithm 1 and algorithm 2) [2]. The management of less acute deteriorations in asthma control are discussed separately. (See "An overview of asthma management", section on 'Adjusting controller medication'.)

The basic principles of care are the following [1,2,4]:

- Assess the severity of the attack and risk for asthma-related death
- Assess potential triggers (eg, inhaled allergens such as animal dander, pollen, and mold; respiratory infection; medications such as beta blockers or nonsteroidal anti-inflammatory drugs [NSAIDs] in susceptible individuals; inhaled irritants such as chemical fumes or cigarette smoking; and medication nonadherence)
- Use an inhaled rapid onset (fast-acting) beta-agonist (ie, albuterol, levalbuterol, albuterol-budesonide, or formoterol-inhaled glucocorticoid combination inhaler) early and frequently
- Start systemic glucocorticoids if there is not an immediate and marked response to the inhaled rapid onset beta-agonist; initiating or increasing the dose of inhaled glucocorticoids may be sufficient in mild exacerbations.
- Make frequent objective assessments of the response to therapy until definite, sustained improvement is documented
- Advise patients who are not responding to initial home or office management to go to an acute care facility or see their asthma provider immediately, especially if they have a history of near-fatal asthmatic attacks
- Educate patients about the principles of self-management for early recognition and treatment of a future attack and develop an "asthma action plan" for recurrent symptoms (see "Asthma education and self-management")

Ideally, patients will assess the severity of an attack at home by following an individualized written "asthma action plan." Asthma action plans are based upon symptoms and peak expiratory flow (PEF) measurements and provide clear instructions on how to detect and

respond to changes in these parameters [1,2]. An example is available through the National Heart Lung and Blood Institute (NHLBI Asthma action plan). Asthma action plans and peak expiratory flow monitoring are discussed separately. (See "Asthma education and self-management", section on 'Asthma action plans' and "Asthma education and self-management", section on 'Attack prevention' and "Peak expiratory flow monitoring in asthma".)

DETECTING AN EXACERBATION

Some patients are very sensitive to increased asthma symptoms, while others perceive reduced airflow only when it becomes marked. For the latter group, a decrease in peak expiratory flow may be the first sign that asthma control is deteriorating.

Symptoms and severity — Symptoms that patients should recognize as suggesting an asthma exacerbation include breathlessness, wheezing, cough, and chest tightness. Some patients also report reduced exercise tolerance and fatigue as symptoms of an asthma exacerbation. Patients who have long-standing asthma are generally able to determine when they have an exacerbation.

Patients who contact their clinician should be asked about the timing of onset, likely cause (if known), severity of symptoms (eg, provoked by exertion, present at rest, causing awakening from sleep), and risk factors for asthma-related death (ie, impaired lung function, oral glucocorticoid use, prior emergency department visits, hospitalization or intubation for asthma) (table 1). Symptoms of a severe exacerbation include intractable coughing, sensation of air hunger, inability to speak in complete sentences because of labored breathing, worsening respiratory distress when attempting to lie flat, and agitation.

Current medications and response to treatment of previous exacerbations should also be explored.

The symptoms of an asthma exacerbation are nonspecific, so the initial assessment should include assessment for other processes that might present with these symptoms, such as acute bronchitis, exacerbation of chronic obstructive pulmonary disease (COPD) or bronchiectasis, pneumonia, heart failure, pulmonary embolism, and inducible laryngeal obstruction (also called vocal cord dysfunction). (See "Evaluation of wheezing illnesses other than asthma in adults".)

Peak expiratory flow — Measurement of expiratory airflow with a peak expiratory flow (PEF) meter (or spirometer) provides an assessment of the severity of airflow limitation [5]. Peak flow measurements take less than one minute to perform and are safe and inexpensive. However,

careful instruction is needed to obtain reliable measurements (table 2). (See "Peak expiratory flow monitoring in asthma".)

Peak flow values can help patients and providers judge the severity of an asthma exacerbation and help guide decision-making regarding treatment and the preferred site of medical care (home, medical office, or emergency department). They provide useful adjunctive data to be combined with assessment of symptoms and physical findings. In our experience their greatest value is detection of severe airflow obstruction in a patient whose history and examination are deceptively benign. Failure to recognize severe airflow obstruction during an asthma exacerbation can result in undertreatment, with potentially life-threatening consequences.

Normal values for PEF differ with sex, height, and age (table 3A-B). Each patient should establish a baseline measure with which to compare future readings. A decrement in PEF of greater than 20 percent from normal, or from the patient's personal best value, signals the presence of an asthma exacerbation. The difference in PEF from the patient's baseline helps one gauge the severity of the change. A PEF ≤50 percent of baseline should be considered a severe attack.

Risk factors for fatal asthma — Some patients are at greater risk for life-threatening and potentially fatal asthma attacks. It is helpful to identify such patients and to educate them about identifying early warning signs of deterioration based on PEF monitoring, following a prednisone-based action plan, and seeking emergency care promptly. (See "Identifying patients at risk for fatal asthma", section on 'Identifying high-risk patients'.)

Risk factors for a fatal asthma attack include (table 1) [2]:

- Previous life-threatening exacerbation (eg, intubation or intensive care unit admission)
- Asthma attack despite current course of oral glucocorticoids
- More than one hospitalization for asthma in the past year
- Three or more emergency department visits for asthma in the past year
- Use of more than one canister of short-acting beta-agonist (SABA) per month
- Comorbidities, such as cardiovascular or chronic lung disease
- Illicit drug use and major psychosocial problems, including depression
- IgE-mediated food allergy in a patient with asthma
- Not currently using inhaled glucocorticoids
- Difficulty perceiving asthma symptoms or severity of exacerbations
- History of poor adherence with asthma medications and/or written asthma action plan

HOME TREATMENT

Patients with an uncomplicated asthma exacerbation, good understanding of their asthma, and good inhaler technique can often be managed at home based on direction from their written asthma action plan or discussion with their asthma provider (algorithm 1). However, home management is not meant to replace supervised medical care in seriously ill patients.

Goals — The goals of home management are to relieve symptoms and improve lung function while at the same time recognizing exacerbations that require urgent medical attention. Early initiation of treatment at home can prevent deterioration to a severe and potentially life-threatening attack. To achieve these goals, the provider can:

- Advise the patient to initiate inhaled fast-acting bronchodilator and determine the need for oral glucocorticoid.
- Triage patients with symptoms suggestive of a severe asthma exacerbation (see 'Symptoms and severity' above) to seek emergency department care. While waiting for the ambulance they should take albuterol or other rapid onset bronchodilator 4 to 6 puffs (preferably with a valved holding chamber) and prednisone 40 to 60 mg orally, if available. (See "Acute exacerbations of asthma in adults: Emergency department and inpatient management".)

  Interventions uniquely available in the emergency department setting are removal from potential asthma triggers in the home environment, close medical observation, rest, reassurance, and, most importantly, the ability of medical providers to respond to worsening lung function and gas exchange in the patient who is deteriorating despite standard therapy and progressing toward respiratory failure.
- Assess need for evaluation and management in the office or urgent care center (eg, unclear severity of exacerbation, patient not able to initiate proper home management, potential comorbidity). (See 'Office management' below.)

Fast-acting bronchodilator — All patients should have access to a rapid onset bronchodilator for quick relief of asthma symptoms caused by bronchoconstriction; a short-acting beta-agonist (SABA; eg, albuterol, levalbuterol) or a combination glucocorticoid with a fast-acting beta-agonist preparation (eg, albuterol-budesonide or budesonide-formoterol) can be used [1,2,4].

Short-acting beta-agonist — When the onset of an exacerbation is recognized, inhaled SABA (eg, albuterol, levalbuterol, or albuterol-budesonide) can be administered by one of the

following methods (table 4) [1,2,6]:

- **Metered dose inhaler** – Two to four inhalations from a metered dose inhaler (depending upon the dose that is typically effective and tolerated by that individual; typically, two inhalations are used for mild to moderate symptoms and four inhalations for more severe symptoms), preferably with a valved holding chamber ("spacer") device.

- **Dry powder inhaler** – Albuterol can be administered by dry powder inhaler (DPI), two to four inhalations of the 90 mcg/actuation DPI; typically, two inhalations are used for mild to moderate symptoms and four inhalations for more severe symptoms. A DPI with 200 mcg/actuation is available outside the United States; one to two inhalations are used for acute exacerbations. A valved holding chamber is **not** used with a DPI.

- **Nebulizer** – A nebulizer treatment (eg, albuterol 2.5 mg in 3 mL or levalbuterol 1.25 mg in 3 mL)

The SABA treatment can be repeated every 20 minutes for one hour (three doses), if needed. Over the course of these three SABA treatments, the patient can determine (based on action plan or clinician guidance) whether to continue self-care at home or seek additional medical attention (algorithm 1). Patients should contact their clinician or proceed to the emergency department if they need high doses of inhaled beta-agonists beyond the first hour of self-treatment. (See 'Triage based on response to home treatment' below.)

Combination glucocorticoid-formoterol — A combination inhaler containing formoterol and a glucocorticoid (GC) is an alternative to an inhaled SABA for quick relief of asthma symptoms [1,2,4]. Formoterol is a long-acting beta-agonist (LABA) with a rapid onset of action comparable to albuterol. The usual dose of GC-formoterol for acute symptom relief is one to two inhalations (4.5 mcg formoterol per inhalation). The treatment can be repeated every 20 minutes up to a total of six inhalations, if needed. Over the course of the three treatments, the patient can determine (based on action plan or clinician guidance) whether to continue self-care at home or seek additional medical attention. The maximum daily dose advised by guidelines is 12 inhalations.

As a management strategy for the treatment of asthma with infrequent symptoms, "as needed" dosing of a combination GC-formoterol inhaler reduces the frequency of severe exacerbations requiring oral glucocorticoid by two-thirds compared with SABA alone (table 5) [7,8]. (See "Initiating asthma therapy and monitoring in adolescents and adults", section on 'Patients with infrequent symptoms (Step 1)' and "Initiating asthma therapy and monitoring in adolescents and adults", section on 'Patients with frequent but not daily symptoms (Step 2)'.)

Risks associated with inhaled epinephrine — Racemic epinephrine liquid for inhalation (eg, Asthmanefrin and S2) and epinephrine inhalers (eg, Primatene Mist) are available over the counter and marketed directly to consumers for temporary relief of asthma symptoms. The FDA has issued a warning about multiple adverse events associated with these products, including symptoms such as chest pain, nausea and vomiting, increased blood pressure, tachycardia, and hemoptysis, and also defective atomizer devices [9]. Epinephrine is NOT beta-2 adrenergic receptor selective, so it carries a greater risk of beta-1 and alpha adrenergic-type adverse effects, especially when used in excess doses.

It is important to ensure that patients have ready access to the more effective, inhaled rapid onset beta-2 selective agonists, such as albuterol and levalbuterol, and to advise against use of the nonselective epinephrine-based products [10-12].

Initiation of oral glucocorticoids — Oral glucocorticoids are indicated for asthma exacerbations that are moderate to severe, characterized by lack of improvement in symptoms and/or by a peak expiratory flow (PEF) <80 percent of personal best or predicted after use of an inhaled fast-acting bronchodilator (eg, albuterol or budesonide-formoterol) [1,2]. The decision to initiate oral glucocorticoids at home incorporates the severity and persistence of current symptoms (eg, nocturnal awakenings, breathlessness with minimal activity, needing repeated beta-agonist doses over one to two days), nature of the stimulus triggering the attack, if known (eg, transient irritant or allergen exposure versus worsening symptoms with a respiratory viral infection), and response to bronchodilator treatment. (See 'Triage based on response to home treatment' below.)

Patients with a history of recurrent, severe asthma exacerbations may be advised to keep oral glucocorticoids available at home and take an initial dose (eg, prednisone 40 to 60 mg) based on certain symptoms and PEF results, and then notify their clinician.

Evidence in favor of treating acute asthma exacerbations with oral glucocorticoids is presented separately. (See "Acute exacerbations of asthma in adults: Emergency department and inpatient management", section on 'Oral glucocorticoids'.)

Inhaled glucocorticoids for mild to moderate exacerbations

Short course of inhaled glucocorticoid — Patients with intermittent asthma who use only a SABA such as albuterol for symptom relief can often be managed with initiation of an inhaled glucocorticoid alone during a mild to moderate exacerbation of asthma. In this context we use a medium to high dose of inhaled glucocorticoids for 10 to 14 days (eg, budesonide DPI 180 mcg/actuation at four inhalations twice daily or fluticasone propionate MDI 220 mcg/inhalation at two inhalations twice daily) [13].

Combination quick relief and glucocorticoid inhaler — Patients with moderate to severe persistent asthma who use a combination formoterol-glucocorticoid inhaler as both maintenance and rescue therapy, a strategy referred to as Maintenance and Reliever Therapy (MART), can take up to six inhalations over the course of one hour, with a maximum recommended dose of 12 inhalations/day, as noted above (table 6). The evidence for MART is described separately. (See 'Combination glucocorticoid-formoterol' above and "Initiating asthma therapy and monitoring in adolescents and adults", section on 'Low-dose maintenance and reliever therapy (MART)' and "Ongoing monitoring and titration of asthma therapies in adolescents and adults", section on 'Patients using anti-inflammatory relievers alone (Step 1 or 2)'.)

A combination glucocorticoid-SABA inhaler has been approved by the US Food and Drug Administration [14], but is not yet widely available outside the United States. Where available, it can be used to treat an acute exacerbation like albuterol, with the advantage, as with combination glucocorticoid-formoterol, of administering anti-inflammatory therapy with each inhalation, so-called "anti-inflammatory rescue" (table 5).

Quadrupling the dose of inhaled glucocorticoid — For adolescents and adults with asthma who are already taking a daily inhaled glucocorticoid as maintenance therapy, a potential alternative to oral glucocorticoids is a substantial increase in the inhaled glucocorticoid dose (ie, four times baseline). Quadrupling the glucocorticoid dose may prevent or reduce the severity or duration of an exacerbation when given early in response to a deterioration in asthma control, such as at the first sign of a viral respiratory infection [2,15,16]. However, parameters that predict which patients would benefit from this approach have not been fully determined.

In our practice, we reserve this strategy for selected patients who have mild to moderate asthma, a mild flare in symptoms, PEF ≥60 percent of predicted, good self-management skills, and no prior history of life-threatening asthma exacerbations. This may be particularly beneficial in patients likely not adherent to their usual asthma therapy [4]. Patients should return to their baseline inhaled glucocorticoid dose after normalization of symptoms and PEF, or at a maximum of 14 days.

Evidence in favor of quadrupling the inhaled glucocorticoid dose includes the following:

- In an open-label trial, 1871 patients (≥16 years old) who were receiving inhaled glucocorticoids for asthma and had one or more exacerbations of asthma in the prior year were assigned to self-management with quadrupling the dose of inhaled glucocorticoids in response to a deterioration in asthma control or self-management without such an increase (non-quadrupling group) [15]. After 12 months of follow-up, 45 percent of the

quadrupling group experienced an exacerbation compared with 52 percent of the non-quadrupling group with an adjusted hazard ratio for the time to a first severe exacerbation of 0.81 (95% confidence interval, 0.71-0.92). As participants in this study had low adherence to their regular inhaled glucocorticoid, it is possible that such patients may particularly benefit from quadrupling therapy. Further study is needed to determine whether certain patient or exacerbation characteristics predict which patients would benefit from this strategy.

- Among 403 patients with a mild increase in asthma symptoms and a small decrease in peak flow (eg, 15 percent for two days or 30 percent for one day), quadrupling the dose of inhaled glucocorticoids, rather than no change, resulted in a decrease in the likelihood of needing oral glucocorticoids (relative risk [RR] 0.43, 95% CI 0.24-0.78) [17].

In contrast, doubling the dose of inhaled glucocorticoids is not adequate to abort an asthma exacerbation once an exacerbation has developed [18-20]. Additionally, quintupling the dose of inhaled glucocorticoids in children with an incipient asthma exacerbation appears ineffective [21]. (See "Acute asthma exacerbations in children younger than 12 years: Overview of home/office management and severity assessment", section on 'Outpatient management'.)

Triage based on response to home treatment — The assessment of response to initial home therapy with a fast-acting bronchodilator (eg, albuterol or budesonide-formoterol) is based on the degree of improvement in symptoms, return of peak flow toward baseline, and course of prior exacerbations. The patient should follow their asthma action plan or contact their clinician for specific instructions.

Good response — If the patient's symptoms (wheezing, dyspnea, cough, chest tightness) resolve and the repeat PEF measurement is ≥80 percent of the patient's predicted or personal best over the course of approximately one hour, then the patient may safely continue home management (algorithm 1). A course of prednisone (40 to 60 mg daily for five to seven days, or equivalent) is advised for patients who are on a maximal dose of controller medication, recently completed a course of prednisone, or have had recurrent symptoms after 24 to 48 hours of increased controller medication.

In contrast, if the patient's symptoms resolve after the initial dose of a fast-acting bronchodilator (eg, two to four inhalations), PEF is ≥80 percent of baseline after the initial dose(s), and they remain improved for three to four hours, oral glucocorticoids are usually not necessary.

Other important interventions include removal of the offending stimulus (if known) and intensifying controller medication. (See "An overview of asthma management", section on

'Adjusting controller medication'.)

Incomplete response — An incomplete response to inhaled fast-acting bronchodilator is manifest by continued or recurring symptoms (eg, within two hours of reliever use) and a PEF between 50 and 80 percent of predicted or personal best [2]. The patient should take high-dose inhaled or oral glucocorticoids according to his or her action plan (algorithm 1). We would note that timely administration of oral glucocorticoids for asthma exacerbations is probably the single most effective strategy for reducing emergency department visits and hospitalizations for acute asthmatic attacks.

Other early interventions include removal of or from the offending stimulus (if known), continued administration of inhaled fast-acting bronchodilators every three to four hours, and intermittent measurements of peak flow to assess response.

Need for urgent medical attention — Patients should seek immediate medical attention if they have worsening symptoms despite three doses of their fast-acting bronchodilator, a PEF ≤50 percent of predicted or personal best, or have a concerning comorbid condition (eg, manifest by fever, chest pain, hypoxemia, tachycardia). (See 'Risk factors for fatal asthma' above.)

Under these circumstances patients should not drive themselves to an urgent care setting.

The inhaled fast-acting bronchodilator should continue to be administered while awaiting additional medical care.

OFFICE MANAGEMENT

For patients who present to the medical office with an asthma exacerbation, a focused history and physical examination should be performed promptly and nearly concurrently with administration of the first dose of short-acting beta-agonist (SABA; albuterol or levalbuterol). A quick assessment should enable the clinician to determine whether the patient's symptoms are due to asthma and can be managed in the office or should be urgently transferred to an emergency department.

Focused assessment and triage — A brief history and physical examination should confirm the diagnosis of an asthma exacerbation, exclude worrisome comorbidities (eg, COVID-19 infection, acute bacterial sinusitis, influenza, pneumonia, pneumothorax), and determine the severity of the exacerbation and risk of impending respiratory failure (algorithm 2).

Physical examination should include assessment of posture (eg, “tripod positioning” with elbows extended and thorax tilted forward), level of consciousness, ability to speak in full sentences, temperature, heart rate, respiratory rate and duration of expiratory phase, blood pressure, use of accessory muscles, presence (or absence) of wheezing, crackles, stridor, symmetry of breath sounds, peripheral edema, and rash or angioedema.

Objective assessments, besides vital signs, include pulse oximetry and peak expiratory flow (PEF).

Indications for urgent transfer to emergency department — For patients with a severe or life-threatening exacerbation, characterized by one or more of the following features, arrangements should be made for transfer to an emergency department while initial treatment is being administered:

- Breathless at rest, sitting forward
- Drowsy, confused, or agitated
- Unable to speak in full sentences
- Respiratory rate >30 breaths/minute
- Heart rate >120 beats/minute
- PEF ≤50 percent predicted or personal best or unable to perform PEF
- Arterial oxygen saturation (SpO_2) <90%

Treatment — The main therapies in the office are prompt and repeated administration of SABAs, early addition of systemic glucocorticoids, and supplemental oxygen, titrated to a pulse oxygen saturation of 93 to 95 percent, if available. (See "Acute exacerbations of asthma in adults: Emergency department and inpatient management", section on 'Oxygen'.)

Inhaled short-acting beta-agonists — For all patients presenting with an exacerbation of asthma, we recommend administration of inhaled SABA [1,2]. In general, we start with 4 puffs by metered dose inhaler (MDI) with a valved holding chamber ("spacer") and careful coaching on proper technique. This dose is repeated every 20 minutes for 1 hour. Alternatively, for patients who have a more severe exacerbation or report lack of benefit with four inhalations at home, we administer up to six puffs by MDI (six separate inhalations), preferably with a valved holding chamber and careful attention to technique.

If the office has nebulizer equipment, the SABA can be nebulized (with appropriate precautions against transmission of COVID-19 infection). For albuterol, the usual dose is 2.5 mg in 3 mL; this may be available in a single-dose vial or in a concentrated form 2.5 mg/0.5 mL that must be diluted with 2.5 mL of sterile saline prior to administration. For levalbuterol, the usual dose is 1.25 mg in 3 mL. Nebulizer treatments can be repeated at 20-minute intervals for the first hour.

(See "Acute exacerbations of asthma in adults: Emergency department and inpatient management", section on 'Inhaled beta-agonists'.)

Systemic glucocorticoids — Nearly all patients with a significant asthma exacerbation (eg, PEF <80 percent of personal best or predicted after initial inhaled beta-agonist) should receive oral glucocorticoids [1,2,4]. A short course of glucocorticoids (eg, equivalent of prednisone 40 to 60 mg/day for five to seven days) significantly reduces the likelihood of a repeat severe exacerbation within the succeeding two weeks and lessens the frequency of persistent severe symptoms evaluated at a two-week telephone follow-up [22,23]. As an alternative, oral dexamethasone (12 to 16 mg) for 1 to 2 doses has shown similar efficacy to a course of prednisone (50 to 60 mg/day for five days) [24,25]. (See "Acute exacerbations of asthma in adults: Emergency department and inpatient management", section on 'Oral glucocorticoids'.)

Patients should be advised about common adverse effects of oral glucocorticoids, such as sleep disturbance, increased appetite, gastric irritation, and mood changes. (See "Major adverse effects of systemic glucocorticoids".)

For glucocorticoid courses lasting three weeks or less, there is no need to taper the dose if patients are also taking inhaled glucocorticoids. (See "Glucocorticoid withdrawal", section on 'HPA suppression unlikely'.)

- **Intramuscular glucocorticoids** — Intramuscular injection of a long-acting glucocorticoid formulation is occasionally used for patients without access to oral medication or at high risk of medical nonadherence, although this therapy is more commonly administered in the emergency department or hospital. For instance, one might administer triamcinolone suspension 40 mg/mL at a dose of 60 to 100 mg intramuscularly. (See "Acute exacerbations of asthma in adults: Emergency department and inpatient management", section on 'Intramuscular glucocorticoids'.)

  Disadvantages of intramuscular glucocorticoids are that the onset of action is slower than oral glucocorticoids (12 to 36 hours after administration) and the duration of effect varies from one individual to another (typically from 2 to 4 weeks). Cutaneous atrophy at the injection site and blanching of the overlying skin are also possible.

Disposition — Patients should be reassessed after SABA treatment to determine whether they will need further emergency department or hospital-based care, can continue therapy at home, or need evaluation of a concerning comorbid condition (eg, influenza, COVID-19 infection, pneumonia, pneumothorax, pulmonary embolism, heart failure, or cardiac arrhythmia). Signs and symptoms that may suggest a comorbid condition include fever, persistent tachycardia, myalgias, purulent sputum, chest pain, hypoxemia, and a poor response to SABA.

Worsening or lack of improvement — Patients who develop worsening symptoms and/or a declining or unimproved PEF (eg, ≤50 percent predicted) despite SABA and systemic glucocorticoid treatment in the office will need transfer to an emergency department for further management. While waiting for transfer, SABA and oxygen (aiming for 93 to 95 percent pulse oxygen saturation) should be continued. Emergency and inpatient care are discussed separately. (See "Acute exacerbations of asthma in adults: Emergency department and inpatient management".)

Improved and preparing for discharge to home — Patients who improve with office-based treatment (ie, symptoms decreased, heart and respiratory rates normal, PEF >70 percent of predicted or personal best, SpO_2 >94 percent room air) can generally manage their asthma at home, unless symptoms or signs suggest a concerning comorbid condition [26]. (See 'Need for urgent medical attention' above.)

Patients will need clear instructions about the following:

- Home monitoring with specific indications for emergency department care or contacting the office (eg, worsening symptoms, increasing need for fast-acting bronchodilator, PEF ≤60 percent of baseline)
- Dose and duration of oral glucocorticoid therapy (eg, equivalent of prednisone 40 to 60 mg daily for five to seven days)
- Potential adverse effects of systemic glucocorticoids (eg, elevated blood glucose, mood alteration, insomnia, excess energy, increased appetite, and fluid retention)
- Use of their reliever (SABA, combination SABA-inhaled glucocorticoid, or combination inhaled glucocorticoid-formoterol) every four to six hours during the first few days of an exacerbation, followed by tapering back to as-needed use as symptoms resolve
- Initiation or increase in ongoing controller medications (eg, inhaled glucocorticoids, long-acting beta-agonist)

Treatment with inhaled glucocorticoids (table 7) constitutes an important method to prevent recurrent asthma attacks after discontinuation of oral glucocorticoids and to prevent the potential decline in lung function associated with any future severe asthma exacerbation [1,27]. Virtually every patient who has an asthma attack severe enough to require office-based or urgent care should receive an inhaled glucocorticoid as part of his or her discharge medication plan (form 1). (See "An overview of asthma management".)

Patients with frequent asthma exacerbations will likely benefit from referral to an asthma specialist. A number of biologic therapies (monoclonal antibodies targeting allergic, eosinophilic, and steroid-dependent asthma phenotypes) are available that successfully reduce the frequency of exacerbations among patients with severe asthma.

Patient education — Patients should be provided with information about asthma, inhaler technique, avoidance of asthma triggers, and if they do not already have one, a personalized action plan (form 1). Follow-up care should be facilitated to ensure adequate and ongoing use of controller medications. (See "Asthma education and self-management" and "Trigger control to enhance asthma management" and 'Information for patients' below.)

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".)

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.)

- Beyond the Basics topics (see "Patient education: Asthma treatment in adolescents and adults (Beyond the Basics)" and "Patient education: Trigger avoidance in asthma (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)")

SUMMARY AND RECOMMENDATIONS

- **Early recognition** – Early recognition and intervention are critical for successful management of asthma exacerbations. Patients with asthma should be taught how to identify symptoms of an asthma exacerbation (eg, breathlessness, wheezing, cough, and chest tightness), and those with poor symptom perception or at increased risk for fatal asthma should be taught how to measure peak expiratory flow (PEF). (See 'Detecting an exacerbation' above.)

- **Algorithms for management** – Approaches to the management of acute exacerbations of asthma at home and in the medical office are outlined in the algorithms (algorithm 1 and algorithm 2). Patients should seek immediate emergency department care if they have symptoms or signs suggestive of a severe exacerbation (eg, marked breathlessness, inability to speak more than short phrases, use of accessory muscles) or a PEF ≤50 percent of baseline, or have risk factors for a fatal attack (table 1). (See 'Need for urgent medical attention' above.)

- **Prompt initiation of therapy** – Regardless of the treatment location (home or office), the following pharmacologic interventions are the cornerstone of therapy:

  - **Fast-acting beta-agonist** – For all patients with symptoms of an asthma exacerbation, we recommend prompt administration of a rapid onset (fast-acting) beta-agonist (**Grade 1B**), either in the form of a short-acting beta-agonist (SABA) or the long-acting beta-agonist (LABA) formoterol. Formoterol has an onset of action comparable to albuterol and must be given in a combination inhaler with a glucocorticoid (GC). (See 'Fast-acting bronchodilator' above.)

    SABA – The usual dose of SABA (albuterol, levalbuterol, or albuterol-budesonide) at home is two to four inhalations from a metered-dose inhaler (albuterol MDI 90 mcg/inhalation; levalbuterol MDI 45 mcg/inhalation) with a valved holding chamber ("spacer") or dry powder inhaler (albuterol DPI 90 mcg/actuation), while in the office four to six inhalations can be given. Albuterol or levalbuterol can also be given by nebulizer (2.5 mg or 1.25 mg, respectively). Dosing can be repeated every 20 minutes for one hour (three doses), as needed. (See 'Short-acting beta-agonist' above and 'Inhaled short-acting beta-agonists' above.)

    Inhaled GC-formoterol – The usual dose of inhaled GC-formoterol for an acute exacerbation (eg, budesonide-formoterol 80 mcg-4.5 mcg or 160 mcg-4.5 mcg) is one to two inhalations, which can be repeated every 20 minutes for one hour (6

inhalations/treatment; maximum 12 inhalations/day), if needed. (See 'Combination glucocorticoid-formoterol' above.)

- **Oral glucocorticoids** – For patients whose symptoms have been recurrent over one to two days or do not improve after one to three doses of fast-acting beta-agonist and/or whose PEF remains <80 percent of personal best or predicted, we recommend initiation of oral glucocorticoids (**Grade 1B**). The typical initial dose is the equivalent of prednisone 40 to 60 mg orally. (See 'Initiation of oral glucocorticoids' above.)

- **Trigger avoidance and monitoring response** – Additional steps at home include removal from sources of potential triggers (eg, animal dander, tobacco smoke) and monitoring of medication response (algorithm 1). (See 'Home treatment' above.)

- **Treatment in medical office** – For patients who present to the medical office with an asthma exacerbation, a focused history and physical examination should be performed promptly and nearly concurrently with administration of the first dose of SABA (algorithm 2). (See 'Office management' above.)

  - **Signs of severe exacerbation** – Patients with features of a severe or life-threatening asthma exacerbation (eg, breathless at rest, unable to speak in full sentences, heart rate >120/minute, respiratory rate >30/minute, PEF ≤50 percent of predicted or personal best, pulse oxygen saturation <90 percent) should be urgently transferred to an emergency department. (See 'Indications for urgent transfer to emergency department' above.)

  - **Supplemental oxygen** – Supplemental oxygen should be titrated to a pulse oxygen saturation of 93 to 95 percent, if necessary. (See 'Office management' above.)

  - **Oral glucocorticoids** – Most patients who require office-based treatment for an acute asthma exacerbation and have a PEF <80 percent of predicted or personal best after initial SABA treatment are candidates for oral glucocorticoids. An initial dose can be administered in the office (eg, prednisone 40 to 60 mg or equivalent), if available. (See 'Systemic glucocorticoids' above.)

- **Disposition** – After office-based fast-acting beta-agonist treatment, patients who have no improvement or have worsening symptoms and/or a declining PEF will need transfer to an emergency department for further management. (See 'Worsening or lack of improvement' above.)

Patients who are treated in the office and are improved enough to go home should complete a course of glucocorticoids (equivalent of prednisone 40 to 60 mg daily for five to seven days). They should be given instructions for their long-term controller medication (inhaled glucocorticoids with or without a long-acting beta-agonist), a personalized asthma action plan (NHLBI Asthma Action Plan), and follow-up care instructions (form 1). (See 'Disposition' above.)

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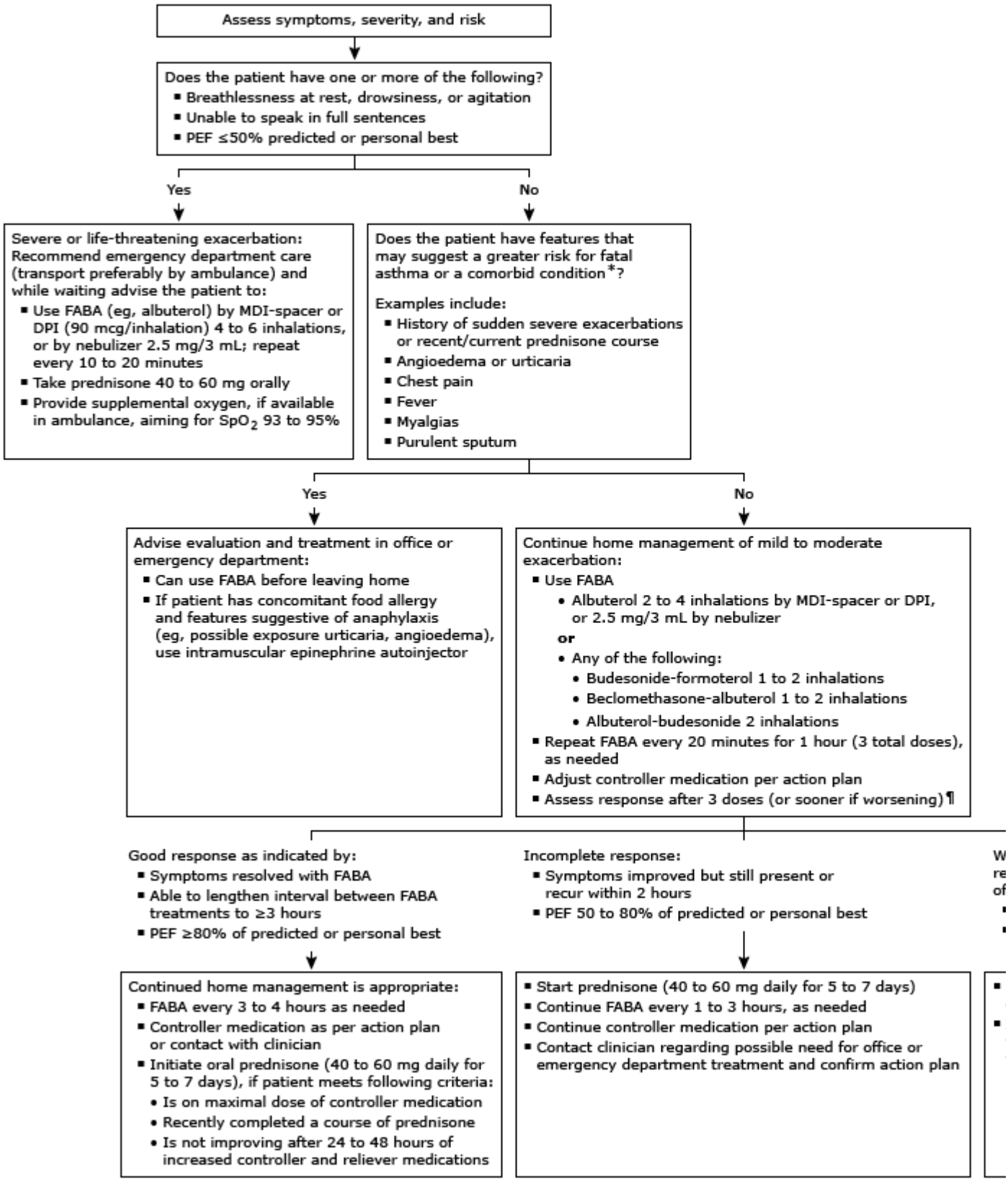
Topic 528 Version 80.0

GRAPHICS

Our approach to initial triage and home management of asthma exacerbations in adults and adolescents



This algorithm is designed for a medical professional providing advice to a patient who is at home and has an asthma exacerbation. More than one phone call may be needed to complete the algorithm.

DPI: dry powder inhaler; FABA: fast-acting beta agonist (eg, albuterol albuterol-budesonide formoterol-inhaled glucocorticoid combination inhaler); MDI: pressurized metered dose inhaler; PEF: peak expiratory flow; SpO_2: pulse oxygen saturation.

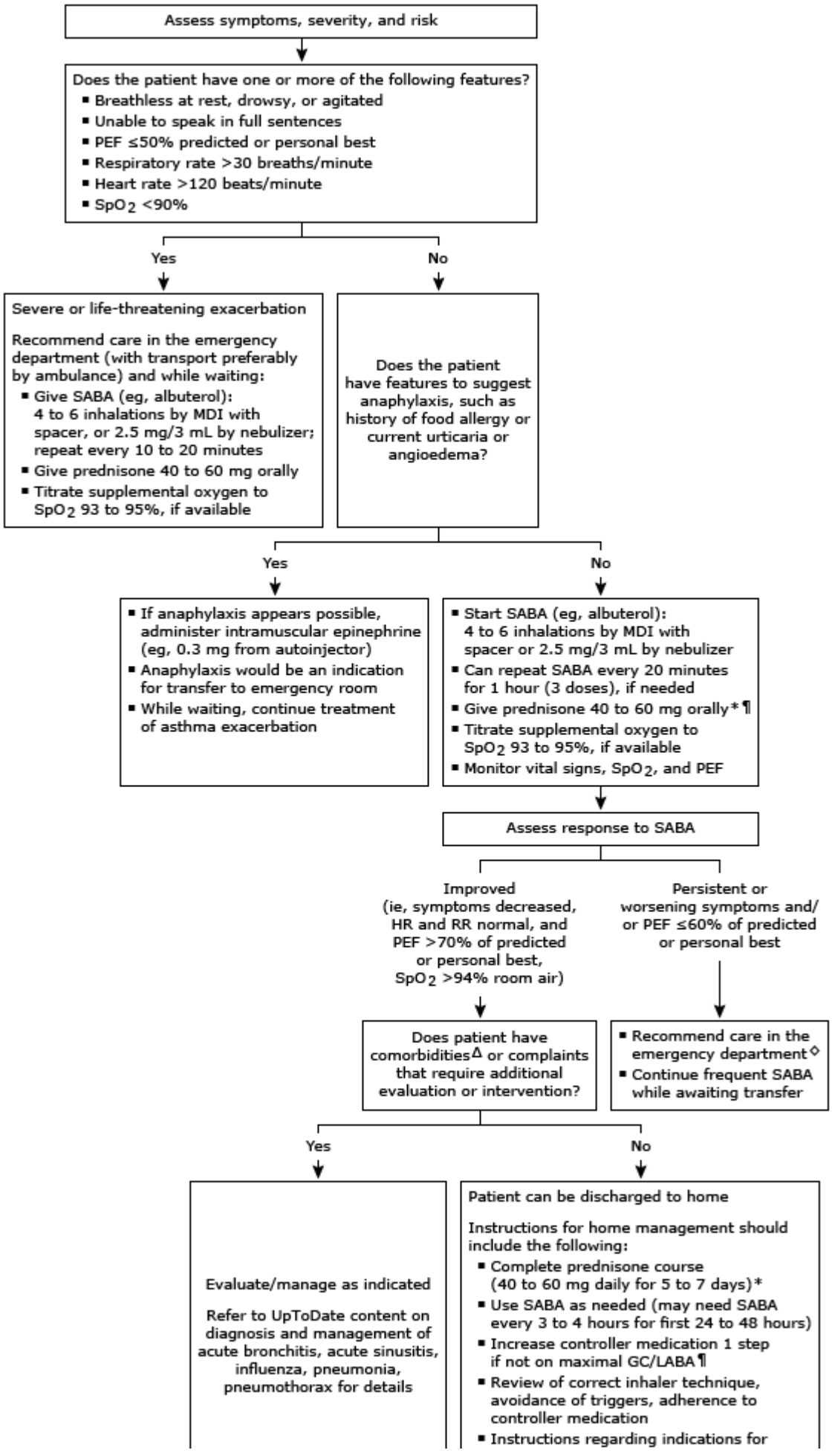
* Comorbid conditions that may complicate asthma exacerbation:
- Acute bronchitis
- Acute bacterial sinusitis
- Anaphylaxis
- Heart failure, arrhythmias
- Influenza, COVID-19
- Pneumonia
- Pneumothorax

¶ Response category is generally based on the criterion with the most severe impairment.

Reference: Global Initiative for Asthma. Global Strategy for Asthma Management and Prevention, 2021. Available from: www.ginasthma.org (Accessed on December 3, 2021).

Graphic 119823 Version 5.0

Our approach to office management of asthma exacerbations in adults and adolescents


Assess symptoms, severity, and risk
Does the patient have one or more of the following features?
Breathless at rest, drowsy, or agitated
Unable to speak in full sentences
PEF ≤50% predicted or personal best
Respiratory rate >30 breaths/minute
Heart rate >120 beats/minute
SpO2 <90%
Yes
No
Severe or life-threatening exacerbation
Recommend care in the emergency department (with transport preferably by ambulance) and while waiting:
Give SABA (eg, albuterol): 4 to 6 inhalations by MDI with spacer, or 2.5 mg/3 mL by nebulizer; repeat every 10 to 20 minutes
Give prednisone 40 to 60 mg orally
Titrate supplemental oxygen to SpO2 93 to 95%, if available
Does the patient have features to suggest anaphylaxis, such as history of food allergy or current urticaria or angioedema?
Yes
No
If anaphylaxis appears possible, administer intramuscular epinephrine (eg, 0.3 mg from autoinjector)
Anaphylaxis would be an indication for transfer to emergency room
While waiting, continue treatment of asthma exacerbation
Start SABA (eg, albuterol): 4 to 6 inhalations by MDI with spacer or 2.5 mg/3 mL by nebulizer
Can repeat SABA every 20 minutes for 1 hour (3 doses), if needed
Give prednisone 40 to 60 mg orally* ¶
Titrate supplemental oxygen to SpO2 93 to 95%, if available
Monitor vital signs, SpO2, and PEF
Assess response to SABA
Improved (ie, symptoms decreased, HR and RR normal, and PEF >70% of predicted or personal best, SpO2 >94% room air)
Persistent or worsening symptoms and/or PEF ≤60% of predicted or personal best
Does patient have comorbidities Δ or complaints that require additional evaluation or intervention?
Recommend care in the emergency department ◇
Continue frequent SABA while awaiting transfer
Yes
No
Evaluate/manage as indicated
Refer to UpToDate content on diagnosis and management of acute bronchitis, acute sinusitis, influenza, pneumonia, pneumothorax for details
Patient can be discharged to home
Instructions for home management should include the following:
Complete prednisone course (40 to 60 mg daily for 5 to 7 days)*
Use SABA as needed (may need SABA every 3 to 4 hours for first 24 to 48 hours)
Increase controller medication 1 step if not on maximal GC/LABA ¶
Review of correct inhaler technique, avoidance of triggers, adherence to controller medication
Instructions regarding indications for

PEF: peak expiratory flow; SpO_2: pulse oxygen saturation; SABA: short-acting beta-agonist; MDI: metered dose inhaler; GC: glucocorticoid; LABA: long-acting beta-agonist.

* In a minority of patients, symptoms resolve quickly and completely with one dose of albuterol (eg, 2 to 4 inhalations or one nebulizer treatment) and PEF is ≥80% of predicted or personal best. Oral glucocorticoid is not necessary, but a step-up in controller medication may be needed.

¶ Refer to UpToDate content on asthma management or https://ginasthma.org/.

Δ Comorbid conditions that may complicate asthma exacerbation include the following:

- Acute bronchitis
- Acute bacterial sinusitis
- Heart failure; arrhythmia
- Influenza, COVID-19
- Pneumonia
- Pneumothorax

Suggestive symptoms include fever, myalgias, purulent sputum, chest pain, poor response to SABA. Refer to UpToDate content on diagnosis and management.

◇ Individuals with PEF 60-70% of predicted following initial treatment can sometimes safely continue treatment at home if their symptoms are improving, they have an asthma-safe home environment, have the necessary medications and understand their proper administration, are deemed adherent to therapy, and have ready access to emergent care if needed.

Reference: Global Initiative for Asthma. Global Strategy for Asthma Management and Prevention. Available from: www.ginasthma.org. (Accessed on December 15, 2021)

Graphic 119824 Version 2.0

Risk factors for a fatal asthma attack

Indicators of severe disease
▪ Previous life-threatening exacerbation
▪ Asthma attack despite current oral glucocorticoid use
Indicators of poor asthma control
▪ More than 1 hospitalization for asthma in the past year
▪ 3 or more emergency department visits for asthma in the past year
▪ Use of more than 1 canister of short-acting beta agonist per month
Serious comorbidities
▪ Cardiovascular or chronic lung disease
▪ Illicit drug use or major psychosocial problems
▪ Food allergy
Poor asthma co-management skills
▪ Not taking inhaled glucocorticoids
▪ History of poor adherence with asthma medications and/or written asthma action plan
▪ Difficulty perceiving asthma symptoms or severity of exacerbations

Graphic 119887 Version 1.0

Technique for peak flow measurement in asthma

Move peak flow meter indicator to zero.
Sit or stand up straight.
Take in a deep breath, as deep as you can.
Place peak flow meter in your mouth and close your lips around the mouthpiece*.
As soon as your lips are sealed around mouth piece, blow out as hard and fast as you can using your chest and belly muscles¶. This should take no more than 2 seconds.
Write down the result.
Repeat two more times (three total).
Record the highest of the three values.

* Nose clips are not necessary.

¶ Make sure to use all of your breathing muscles, not just your mouth muscles. This needs a lot of force, like blowing out a candle several feet away.

Graphic 53856 Version 5.0

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

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

Usual doses of short-acting bronchodilators for asthma in adolescents and adults*

Drug name(s)	Preparation(s)¶	Dose
Albuterol MDI[Δ]	MDI: 90 mcg/inhalation (United States) MDI: 100 mcg/inhalation (Canada)	▪ Usual dose: 2 inhalations every 4 to 6 hours as needed ▪ Acute exacerbation at home: 2 to 4 inhalations, can be repeated every 20 minutes for a total of 3 doses, then as directed[◇] ▪ Acute care setting: 4 to 8 inhalations every 20 minutes for 3 doses[§], then taper depending on response to therapy
Albuterol DPI	DPI[Δ]: 90 mcg/actuation (United States)	▪ Usual dose: 2 inhalations every 4 to 6 hours, as needed ▪ Acute exacerbation at home: 2 to 4 inhalations, can be repeated every 20 minutes for a total of 3 doses, then as directed[◇] ▪ Acute care setting: 4 to 8 inhalations every 20 minutes for 3 doses[§], then taper depending on response to therapy
Albuterol DPI (Canada)	DPI: 200 mcg/actuation (Canada)	▪ Usual dose: 1 inhalation every 4 to 6 hours, as needed ▪ Exercise-induced bronchoconstriction: 1 inhalation 15 minutes prior to exercise
Albuterol solution for nebulization	Nebulizer solutions: ▪ 0.083% (2.5 mg/3 mL) ▪ 0.5% (2.5 mg/0.5 mL) concentrate; must be diluted in 2.5 mL saline	▪ Usual dose: 2.5 mg every 4 to 6 hours, as neede ▪ Acute exacerbation at home: Administer 2.5 mg, can repeat every 20 minutes for total of 3 doses, then decrease frequency to every 1 to 4 hours, as tolerated[¥] ▪ Acute care setting: Administer 2.5 to 5 mg, can repeat every 20 minutes for total of 3 doses, then decrease frequency to every 1 to 4 hours, as tolerated ▪ Acute care setting (critically ill): Continuous nebulizer treatment: Use a large volume nebulizer, 10 to 15 mg/hour in monitored settin
Albuterol-budesonide MDI	MDI: Albuterol 90 mcg and budesonide 80 mcg/actuation (United States)	▪ Usual dose: 2 inhalations every 4 to 6 hours as needed ▪ Acute exacerbation at home: 2 inhalations, can be repeated every 20 minutes for a total of 3

		doses, then as directed[¥]
Levalbuterol MDI[Δ]	45 mcg/inhalation (United States)	▪ Usual dose: 2 inhalations every 4 to 6 hours, as needed ▪ Acute exacerbation at home: 2 to 4 inhalations; can be repeated every 20 minutes for a total of 3 doses, then as directed[◇] ▪ Acute care setting: 4 to 8 inhalations every 20 minutes for 3 doses, then taper depending on response to therapy[§]
Levalbuterol solution for nebulization	Nebulizer solution: ▪ 0.63 mg/3 mL ▪ 1.25 mg/3 mL ▪ 1.25 mg/0.5 mL concentrate; must be diluted in 2.5 mL saline	▪ Usual dose: Administer 0.63 to 1.25 mg (equivalent to 1.25 to 2.5 mg albuterol) every 6 to 8 hours, as needed (up to 3 doses per 24 hours) ▪ Acute exacerbation at home: Administer 1.25 mg; can be repeated every 20 minutes for a total of 3 doses, then decrease frequency to every 1 to 4 hours, as tolerated[¥] ▪ Acute care setting: Administer 1.25 mg to 2.5 mg (equivalent to 2.5 to 5 mg of albuterol); can repeat every 20 minutes for total of 3 doses, then decrease frequency to every 1 to 4 hours, as tolerated
Terbutaline DPI	DPI: 0.5 mg/actuation (Canada)	▪ Usual dose: 1 inhalation every 4 hours, as needed ▪ If no effect after 5 minutes, can repeat dose
Ipratropium-albuterol SMI	SMI: Ipratropium 20 mcg and albuterol 100 mcg/inhalation (United States)	▪ Usual dose (off-label): 2 inhalations every 6 hours, as needed ▪ Acute exacerbation (off-label): 4 to 8 inhalations every 20 minutes for 3 doses, and then as needed for up to 3 hours
Ipratropium-albuterol solution for nebulization	Nebulizer solution: Ipratropium 0.5 mg and albuterol 2.5 mg per 3 mL/vial[‡]	▪ Usual dose (off-label): Administer 1 vial (3 mL) every 4 to 6 hours, as needed ▪ Acute exacerbation (off-label): Administer 1 vial (3 mL), every 20 minutes for 3 doses, and then as needed for up to 3 hours[¥]

MDI: metered-dose inhaler; DPI: dry-powder inhaler; SMI: soft mist inhaler.

* Oral formulations of albuterol and terbutaline are less effective than inhaled formulations and are not recommended in asthma. Inhaled epinephrine (MDI or nebulized) is not recommended for routine use.

¶ Doses shown and strengths (ie, mcg per puff or inhalation) are based upon product descriptions approved in the United States and Canada as noted, which may differ from how strengths are described

for products available in other countries. Consult local product information before use.

Δ Agent can also be used to prevent exercise-induced bronchoconstriction, 2 inhalations 5 to 20 minutes prior to exercise.

◇ Typically, two puffs are used for mild-to-moderate symptoms and four puffs for more severe symptoms; over the course of the first hour, the patient can determine (based on action plan or clinician guidance) whether to continue self-care at home or seek additional medical attention.

§ The number of inhalations is based on the severity of respiratory impairment, number of inhalations the patient has already used, and availability of monitoring. When administering an albuterol MDI for acute asthma exacerbation in an office or acute care setting, use of a valved holding chamber and careful attention to technique are recommended.

¥ Over the course of the first hour, the patient can determine (based on action plan or clinician guidance) whether to continue self-care at home or seek additional medical attention.

‡ Nebulizer solution in Canada is ipratropium 0.5 mg and albuterol 2.5 mg per 2.5 mL.

Graphic 72467 Version 27.0

Usual dosing of anti-inflammatory reliever (AIR) therapy

Drug name(s)	Preparation(s)	Dose
Inhaled corticosteroid and short-acting beta-agonist (ICS-SABA)		
Albuterol-budesonide MDI[*] (Brand name [United States]: Airsupra)	MDI: Albuterol 90 mcg and budesonide 80 mcg/actuation	▪ Usual dose: 2 inhalations as needed up to a maximum of 12 inhalations per day ▪ Acute exacerbation at home: 2 inhalations; may repeat every 20 minutes for a total of 6 inhalations, then as directed[¶]
ICS and formoterol combinations[Δ◇]		
Budesonide-formoterol MDI (Brand names [United States]: Symbicort, Breyna)	MDI: Budesonide 80 mcg and formoterol 4.5 mcg/actuation MDI: Budesonide 160 mcg and formoterol 4.5 mcg/actuation	▪ Usual dose: • 80 mcg/4.5 mcg: 1 to 2 inhalation as needed; some experts use 2 inhalations unless infrequent rescue inhaler use; maximum dose: 12 inhalations per day • 160 mcg/4.5 mcg: 1 inhalation as needed; if symptoms persist after a few minutes, may repeat; maximum dose: 12 inhalations per day ▪ Acute exacerbation at home: 1 to 2 inhalations as needed; wait for a few minutes between doses and use second dose if symptoms persist; may repeat 1 to 2 inhalations every 20 minutes for up to 6 inhalations in 1 hour, then as directed[¶]
Budesonide-formoterol DPI[§] (Brand name [Canada]: Symbicort Forte)	DPI: Budesonide 100 mcg and formoterol 6 mcg/actuation DPI: Budesonide 200 mcg and formoterol 6 mcg/actuation	▪ Usual dose: • 100 mcg/6 mcg: 1 to 2 inhalations as needed; some experts use 2 inhalations unless infrequent rescue inhaler use; maximum dose: 12 inhalations per day • 200 mcg/6 mcg: 1 inhalation as needed; if symptoms persist after a few minutes, may repeat; maximum dose: 12 inhalations per day

		▪ Acute exacerbation at home: 1 to 2 inhalations as needed; wait for a few minutes between doses and use second dose if symptoms persist; may repeat 1 to 2 inhalations every 20 minutes for up to 6 inhalations in 1 hour, then as directed[¶]
Mometasone-formoterol MDI (Brand names: Dulera [United States], Zenhale [Canada])	MDI: Mometasone 100 mcg and formoterol 5 mcg/actuation MDI: Mometasone 200 mcg and formoterol 5 mcg/actuation	▪ Usual dose: 1 inhalation as needed; if insufficient relief, may administer a second dose a few minutes later; maximum dose: 12 inhalations per day ▪ Acute exacerbation at home: 1 to 2 inhalations as needed; wait for a few minutes between doses and use second dose if symptoms persist; may repeat 1 to 2 inhalations every 20 minutes for up to 6 inhalations in 1 hour, then as directed[¶]
Beclomethasone [beclometasone]-formoterol DPI[§] or MDI (Not available in United States or Canada, but available elsewhere [sample brand names: Formodual, Fostair, Foster])	DPI or MDI: Beclomethasone 100 mcg and formoterol 6 mcg/actuation DPI or MDI: Beclomethasone 200 mcg and formoterol 6 mcg/actuation	▪ Usual dose: 1 inhalation as needed; if insufficient relief, may administer a second dose a few minutes later; maximum dose: 12 inhalations per day ▪ Acute exacerbation at home: 1 to 2 inhalations as needed; wait for a few minutes between doses and use second dose if symptoms persist; may repeat 1 to 2 inhalations every 20 minutes for up to 6 inhalations in 1 hour, then as directed[¶]
Fluticasone propionate-formoterol MDI (Not available in United States or Canada, but available elsewhere [sample brand name: Flutiform])	MDI: Fluticasone 50 mcg and formoterol 5 mcg/actuation MDI: Fluticasone 125 mcg and formoterol 5 mcg/actuation MDI: Fluticasone 250 mcg and formoterol 5 mcg/actuation	▪ Usual dose: • 50 mcg/5 mcg: 1 to 2 inhalations as needed; some experts use 2 inhalations unless infrequent rescue inhaler use; maximum dose: 12 inhalations per day • 125 mcg/5 mcg or 250 mcg/5 mcg: 1 inhalation as needed; if symptoms persist after a few minutes, may repeat; maximum dose: 12 inhalations per day ▪ Acute exacerbation at home: 1 to 2 inhalations as needed; wait for a few

		minutes between doses and use second dose if symptoms persist; may repeat 1 to 2 inhalations every 20 minutes for up to 6 inhalations in 1 hour, then as directed¶

Dose per actuation is according to United States prescribing information, unless otherwise noted, which may differ from how strengths are described in other countries. Consult local product information. Use of AIR on a daily or more frequent basis over a four-week period suggests poor asthma control and should prompt provider evaluation.

AIR: anti-inflammatory reliever; DPI: dry powder inhaler; MDI: metered-dose inhaler.

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

¶ Over the course of the first hour, the patient can determine (based on action plan or clinician guidance) whether to continue self-care at home or seek additional medical attention. When administering an MDI for acute asthma exacerbation, use of a valved holding chamber (for compatible MDIs) and careful attention to technique are recommended.

Δ Do not exceed the maximum number of inhalations per day due to the risk of toxicity from an excess dose of formoterol. Guidelines published by the Global Initiative for Asthma (GINA) recommend a maximum dose of 12 inhalations per day; however, in some countries, prescribing information includes a maximum dose of 8 inhalations per day.

◇ Evidence for AIR-only therapy is with budesonide-formoterol 200 mcg/6 mcg DPI inhalers. Other strengths or formulations may be used based on local product availability or as part of maintenance and reliever therapy (MART). Refer to related table for more detail on MART dosing.

§ DPIs contain lactose which may have small amounts of milk protein.

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1. *National Heart, Lung, and Blood Institute. National Asthma Education and Prevention Program: Expert panel report III: Guidelines for the diagnosis and management of asthma. Revised August 2007 (NIH publication no. 07-4051). Available at: https://www.nhlbi.nih.gov/health-topics/guidelines-for-diagnosis-management-of-asthma (Accessed November 3, 2023).*
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3. *Global Initiative for Asthma (GINA). Global strategy for asthma management and prevention, 2023. Updated July 2023. Available at: https://ginasthma.org/2023-gina-main-report/ (Accessed November 8, 2023).*
4. *Symbicort Forte Turbuhaler. Health Canada-approved product monograph. Revised February 8, 2021. Health Canada. https://health-products.canada.ca/dpd-bdpp/info?lang=eng&code=72555 (Accessed November 8, 2023).*

Graphic 143331 Version 2.0

Usual doses of ICS-formoterol preparations for maintenance and reliever therapy

Medication and dose per actuation	Low-dose	Medium-dose	High-dose
Budesonide-formoterol MDI (brand names [United States]: Symbicort, Breyna)			
80 mcg/4.5 mcg	2 inhalations twice daily* **plus** 1 to 2 inhalations as needed; some experts use 2 inhalations unless infrequent rescue inhaler use¶Δ		
160 mcg/4.5 mcg	1 inhalation twice daily **or** 2 inhalations once daily* **plus** 1 inhalation as needed; if symptoms persist after a few minutes, may repeat¶Δ	2 inhalations twice daily **plus** 1 inhalation as needed; if symptoms persist after a few minutes, may repeat¶Δ	
Budesonide-formoterol DPI◇ (brand name [Canada]: Symbicort Forte)			
100 mcg/6 mcg	2 inhalations twice daily* **plus** 1 to 2 inhalations as needed; some experts use 2 inhalations unless infrequent rescue inhaler use¶Δ		
200 mcg/6 mcg	1 inhalation twice daily **or** 2 inhalations once daily* **plus** 1 inhalation as needed; if symptoms persist	2 inhalations twice daily **plus** 1 inhalation as needed; if symptoms persist after a few minutes, may repeat¶Δ	

	after a few minutes, may repeat[¶Δ]		
Mometasone-formoterol MDI (brand name: Dulera [United States]; Zenhale [Canada])			
100 mcg/5 mcg		2 inhalations twice daily **plus** 1 inhalation as needed; if symptoms persist after a few minutes, may repeat[¶Δ]	
200 mcg/5 mcg			2 inhalations twice daily **plus** 1 inhalation as needed; if symptoms persist after a few minutes, may repeat[¶Δ]
Beclomethasone [beclometasone]-formoterol DPI[◇] or MDI (not available in United States or Canada, but available elsewhere [sample brand names: Formodual, Fostair, Foster])			
100 mcg/6 mcg	1 inhalation twice daily[*] **plus** 1 inhalation as needed; if symptoms persist after a few minutes, may repeat[¶Δ]	2 inhalations twice daily **plus** 1 inhalation as needed; if symptoms persist after a few minutes, may repeat[¶Δ]	
200 mcg/6 mcg			2 inhalations twice daily **plus** 1 inhalation as needed; if symptoms persist after a few minutes, may repeat[¶Δ]
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[*] **plus** 1 to 2 inhalations as needed; some experts use 2 inhalations unless		

	infrequent rescue inhaler use¶Δ		
125 mcg/5 mcg		2 inhalations twice daily **plus** 1 inhalation as needed; if symptoms persist after a few minutes, may repeat¶Δ	
250 mcg/10 mcg			2 inhalations twice daily **plus** 1 inhalation as needed; if symptoms persist after a few minutes, may repeat¶Δ

Dose per actuation is according to United States prescribing information, unless otherwise noted, which may differ from how strengths are described in other countries. Consult local product information. Off-label use of ICS-formoterol formulations for MART may affect cost or availability.

DPI: dry powder inhaler; ICS: inhaled glucocorticoid (inhaled corticosteroid); MART: maintenance and reliever therapy; MDI: metered-dose inhaler.

* For patients with well-controlled asthma stepping down from low-dose MART, our authors suggest a trial of even lower dose maintenance therapy, achieved by halving the maintenance dose (ie, changing to once daily administration or reducing the number of actuations per dose). Patients with good control on this very low-dose maintenance regimen can be transitioned to anti-inflammatory reliever therapy alone. Refer to related table for more detail on anti-inflammatory reliever therapy dosing.

¶ Maximum total daily dose of maintenance and rescue is 12 inhalations. Do not exceed the maximum number of inhalations per day due to the risk of toxicity from an excess dose of formoterol. In some countries, product labeling includes a maximum total daily dose of eight inhalations. Use of reliever therapy daily or more frequently over a four-week period indicates poor asthma control and should prompt provider evaluation.

Δ For at-home acute exacerbations, one to two inhalations should be taken as needed for initial symptoms. We advise waiting a few minutes between doses, giving the second dose if symptoms persist. One to two inhalations may be repeated every 20 minutes for up to six inhalations in one hour. Over the course of the first hour, the patient can determine (based on action plan or clinician guidance) whether to continue self-care at home or seek additional medical attention. When self-administering an MDI for acute asthma exacerbation, use of a valved holding chamber (for compatible MDIs) and careful attention to technique are recommended.

◇ DPIs contain lactose which may have small amounts of milk protein.

References:

1. *National Heart, Lung, and Blood Institute. National Asthma Education and Prevention Program: Expert panel report III: Guidelines for the diagnosis and management of asthma. Revised August 2007 (NIH publication no. 07-4051). Available at: https://www.nhlbi.nih.gov/health-topics/guidelines-for-diagnosis-management-of-asthma (Accessed November 3, 2023).*
2. *National Heart, Lung, and Blood Institute. 2020 focused updates to the asthma management guidelines: A report from the National Asthma Education and Prevention Program Coordinating Committee Expert Panel Working Group. December 2020 (NIH publication no. 20-HL-8140). Available at: https://www.nhlbi.nih.gov/health-topics/asthma-management-guidelines-2020-updates (Accessed November 3, 2023).*
3. *Global Initiative for Asthma (GINA). Global strategy for asthma management and prevention, 2023. Updated July 2023. Available at: https://ginasthma.org/2023-gina-main-report/ (Accessed November 8, 2023).*
4. *Symbicort Forte Turbuhaler. Health Canada-approved product monograph. Revised February 8, 2021. Health Canada. https://health-products.canada.ca/dpd-bdpp/info?lang=eng&code=72555 (Accessed November 8, 2023).*

Graphic 143330 Version 2.0

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

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