in the clinic

Asthma

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Asthma, which is characterized by airway hyperresponsiveness and inflammation, is one of the most common respiratory illnesses. The global prevalence of asthma is increasing despite the development of new therapeutic approaches. Over the past 20 years, asthma mortality in the United States has declined; however, morbidity, as measured by hospitalizations and emergency department visits, continues to climb. Currently, about 1 in 20 Americans have asthma; in children, recent estimates suggest an incidence as high as 10%. In certain groups of Americans, such as persons of lower socioeconomic status and minority ethnicity, asthma morbidity and mortality are disproportionately high. Such trends are surprising, given the improvement in air quality in the United States and the availability of new pharmacologic therapies.

Diagnosis

What symptoms or elements of clinical history are helpful in diagnosing asthma?

Symptoms that should prompt clinicians to consider asthma are wheezing, dyspnea, cough, difficulty taking a deep breath, and chest tightness (1). Characteristically, asthma symptoms are intermittent and may remit spontaneously or with use of short-acting bronchodilators. Symptoms often vary seasonally or are associated with specific triggers, such as cold, exercise, animal dander, pollen, certain foods, aspirin or nonsteroidal anti-inflammatory drugs, or occupational exposures. Clinicians should also consider the diagnosis of asthma in all adults with chronic cough, especially if cough is nocturnal, seasonal, or related to the workplace or a specific activity.

What physical examination findings are suggestive of asthma?

A careful history to elicit the nature and timing of symptoms is paramount in diagnosing asthma. The physical examination is less helpful unless a patient is having an active exacerbation. The clinician should listen for wheezing during tidal respirations or prolonged expiratory phase of breathing and examine the chest for hyperexpansion. Studies suggest that respiratory signs (wheezing, forced expiratory time, accessory muscle use, respiratory rate, and pulsus paradoxus) may be useful to predict airflow obstruction, but clinicians often disagree about the presence and absence of these signs (1, 2).

The physical examination is sometimes most helpful in looking for evidence of alternative diagnoses. Persistent dry inspiratory crackles, focal wet crackles, or an abnormal cardiac examination all suggest diagnoses other than asthma.

How can clinicians determine whether asthma is the cause of chronic cough in adults?

Coughing may be the only manifestation of asthma in some patients (3). Up to 24% of patients presenting to a specialist with chronic cough after an initial evaluation by a primary care provider may have asthma. Although several protocols are available for the diagnosis of patients with chronic cough, it is not clear which is the best approach. Clinicians often use a trial of empirical asthma therapy, but national guidelines recommend pulmonary function tests for patients with chronic cough of unknown etiology.

What are the indications for spirometry in a patient whose clinical presentation is consistent with asthma?

Fair-quality evidence supports the performance of spirometry in all adult patients and older children suspected of having asthma. Initial pulmonary function testing should include spirometric measurements

1. Li JT, O'Connell EJ. Clinical evaluation of asthma. Ann Allergy Asthma Immunol. 1996;76:1-13; quiz 13-5. [PMID: 8564622]
2. National Heart, Lung, and Blood Institute, National Asthma Education and Prevention Program. Expert Panel Report 2: Guidelines for the diagnosis and management of asthma. Bethesda MD: US Department of Health and Human Services, National Institutes of Health, 1997; Publication 97-4051.
3. Corrao WM, Braman SS, Irwin RS. Chronic cough as the sole presenting manifestation of bronchial asthma. N Engl J Med. 1979;300:633-7. [PMID: 763286]
4. McFadden ER Jr. Exertional dyspnea and cough as preludes to acute attacks of bronchial asthma. N Engl J Med. 1975;292:555-9. [PMID: 1110670]
5. 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;159:179-87. [PMID: 9872837]

of the FEV_1, FVC, and the FEV_1–FVC ratio. If these measurements reveal airflow obstruction, then they should be repeated after administration of a bronchodilator to evaluate the reversibility of airflow obstruction. Reversibility of airflow obstruction defines asthma. Predicted normal values for spirometric measures are population-based and differ with age and ethnicity. Predictive tables are available (5, 6). Postbronchodilator improvement ≥ 12% of the FEV_1 or FVC indicates significant reversibility and therefore increases the likelihood of an asthma diagnosis.

Complete pulmonary function testing that includes lung volumes and diffusing capacity should be considered when there is evidence of a lack of airflow reversibility, or restrictive patterns with diminutions in the FEV_1 and FVC but a normal FEV_1–FVC ratio. These findings suggest chronic obstructive pulmonary disease (COPD) or interstitial lung disease (Table 1).

A number of studies show a poor correlation among the presence, severity, and timing of wheezing and the degree of airflow obstruction (7, 8). Patients vary in their degree of sensitivity to airflow limitations and can acclimate to the disability and thus become insensitive to airflow obstruction (9). Because of the disparity between patient and physician estimates of the severity of airflow obstruction and objective measures of obstruction, pulmonary function tests are important tools to characterize airflow obstruction and the degree and severity of asthma.

Spirometry should adhere to the standards of the American Thoracic Society (10). Of note, spirometry is effort-dependent, and many patients have difficulty with the FVC maneuver. In these patients (younger children, older adults, or patients with severe respiratory disease), alternative approaches, such as the FEV_6 may be an acceptable surrogate to the FVC, with a reduction in the FEV_1–FEV_6 ratio signifying obstruction (11).

Table 1. Laboratory and Other Studies for Asthma

Test	*Notes*
Spirometry	Abnormal spirometry (reversible obstruction) can help to confirm an asthma diagnosis, but normal spirometry does not exclude asthma.
Peak flow variability	A patient with normal spirometry but marked diurnal variability (based on a peak flow diary kept for >2 weeks) may have asthma, which may warrant an empirical trial of asthma mediations or further testing with bronchoprovocation.
Bronchoprovocation test	In a patient with a highly suggestive history of asthma and normal baseline spirometry, a low PC_{20} (the concentration of inhaled methacholine needed to cause a 20% drop in the FEV_1) on methacholine challenge testing supports a diagnosis of asthma. Cold air, exercise, and histamine are other types of provocative tests used. A normal bronchoprovocation test will almost definitively exclude asthma.
Chest radiography	Chest radiography may be needed to exclude other diagnoses but is not recommended as a routine test in the initial evaluation of asthma.
Complete blood count with differential	Although mild eosinophilia is not uncommon in persons with asthma, routine use of a CBC with leukocyte differential is not warranted in the initial evaluation.
Sputum evaluation	Routine sputum evaluation is not indicated for the initial evaluation of asthma.
IgE	Although elevated levels of IgE are not uncommon for persons with asthma, routine measurement of serum IgE is not warranted in the initial evaluation
Quantitative IgE antibody assays and skin testing for immediate hypersensitivity to aeroallergens	There is a strong association between allergen sensitization, exposure, and asthma. Allergy testing is the only reliable way to detect the presence of specific IgE to indoor allergens. Skin testing (or in vitro testing) may be indicated to guide the management of asthma in selected patients, but results are not useful in establishing the diagnosis of asthma.

6. Nunn AJ, Gregg I. New regression equations for predicting peak expiratory flow in adults. BMJ. 1989;298:1068-70. [PMID: 2497892]
7. McFadden ER Jr., Kiser R, DeGroot WJ. Acute bronchial asthma. Relations between clinical and physiologic manifestations. N Engl J Med. 1973;288:221-5. [PMID: 4682217]
8. Shim CS, Williams MH Jr. Relationship of wheezing to the severity of obstruction in asthma. Arch Intern Med. 1983;143:890-2. [PMID: 6679232]
9. Chetta A, Gerra G, Foresi A, Zaimovic A, Del Donno M, Chittolini B, et al. Personality profiles and breathlessness perception in outpatients with different gradings of asthma. Am J Respir Crit Care Med. 1998;157:116-22. [PMID: 9445288]
10. Standardization of Spirometry, 1994 Update. American Thoracic Society. Am J Respir Crit Care Med. 1995;152:1107-36. [PMID: 7663792]
11. Swanney MP, Jensen RL, Crichton DA, Beckert LE, Cardno LA, Crapo RO. FEV(6) is an acceptable surrogate for FVC in the spirometric diagnosis of airway obstruction and restriction. Am J Respir Crit Care Med. 2000;162:917-9. [PMID: 10988105]

Does normal spirometry rule out a diagnosis of asthma?

Abnormal spirometry (reversible obstruction) can confirm an asthma diagnosis, but normal spirometry does not rule out asthma. Clinicians should consider further studies in patients with normal spirometry who have a clinical history suggestive of asthma (Table 1). Bronchoprovocation with methacholine or histamine can be helpful in establishing a diagnosis in patients who report that they only have symptoms during exercise or at certain times of the year. Alternatively, marked diurnal variability based on measurements recorded in a peak flow diary kept for at least 2 weeks can help to establish asthma as the cause of symptoms. However, peak flow measurements are highly effort-dependent and may offer no opportunity for quality assurance of their accuracy.

When should clinicians consider provocative pulmonary testing?

A gold standard for diagnosis of asthma remains elusive. However, methacholine hyperresponsiveness in the pulmonary function laboratory has high reproducibility and accepted standardization (12). The test is safe but requires sophisticated instrumentation and is labor-intensive and expensive. In a patient with symptoms suggestive of asthma who has normal baseline spirometry, a low PC_{20} (the concentration of inhaled methacholine needed to induce a 20% decrease in the FEV_1) on methacholine challenge testing supports the diagnosis. Studies of methacholine challenge suggest that it is sensitive and has a high negative predictive value for the diagnosis of asthma (13, 14). Although cold air and exercise have been used in research to define mechanisms of bronchoconstriction, methacholine challenge remains the provocative test of choice in patients with normal pulmonary function tests who have symptoms consistent with asthma.

Spirometry before, during, or after exercise may be the only method to document bronchoconstriction in patients with exercise-induced asthma. As an alternative, monitoring peak flow is easy and inexpensive, but the measurement is less precise and limited in reproducibility and sensitivity (15). Because spirometry and peak flow have limitations in sensitivity and specificity, they are probably best used as part of a diagnostic strategy in conjunction with a comprehensive history, physical examination, and other laboratory data (16).

How should clinicians classify asthma severity?

The National Heart Lung and Blood Institute (NHLBI) Expert Panel Report 2 (2) defines asthma severity according to symptoms and spirometric measurements. As shown in Table 2, asthma severity is classified as intermittent, mild, moderate, and severe persistent. Each category is defined by the frequency of rescue inhaler use as well as nocturnal symptoms in conjunction with the FEV_1 or PEFR measurement. It is important to note that decrease in FEV_1 correlates with airflow obstruction and not with changes due to restrictive lung disease.

The initial determination of asthma severity should be made when the patient is receiving no medications. Asthma severity is dynamic—for example, patients who were initially diagnosed as having severe persistent asthma may have symptoms consistent with mild persistent asthma while receiving medication. The NHLBI Expert Panel Report 2 (2) suggests annual spirometry to aid in the classification of asthma, but high-quality studies are not available to support this recommendation.

12. Crapo RO, Casaburi R, Coates AL, Enright PL, Hankinson JL, Irvin CG, et al. Guidelines for methacholine and exercise challenge testing-1999. This official statement of the American Thoracic Society was adopted by the ATS Board of Directors, July 1999. Am J Respir Crit Care Med. 2000;161:309-29. [PMID: 10619836]
13. Cockcroft DW, Killian DN, Mellon JJ, Hargreave FE. Bronchial reactivity to inhaled histamine: a method and clinical survey. Clin Allergy. 1977;7:235-43. [PMID: 908121]
14. Hopp RJ, Bewtra AK, Nair NM, Townley RG. Specificity and sensitivity of methacholine inhalation challenge in normal and asthmatic children. J Allergy Clin Immunol. 1984;74:154-8. [PMID: 6747136]
15. Jain P, Kavuru MS, Emerman CL, Ahmad M. Utility of peak expiratory flow monitoring. Chest. 1998;114:861-76. [PMID: 9743179]
16. Perpiñá M, Pellicer C, de Diego A, Compte L, Macián V. Diagnostic value of the bronchial provocation test with methacholine in asthma. A Bayesian analysis approach. Chest. 1993;104:149-54. [PMID: 8325060]

Table 2. The Step Classification of Asthma Severity*

Classification	*Symptoms†*	*Nocturnal Symptoms*	*Lung Function*
Step 1: Mild intermittent	Symptoms ≤2 per week Asymptomatic and normal PEFR between exacerbations Exacerbations brief (a few hours to a few days); intensity may vary	2 per month	FEV_1 or PEFR ≥80% predicted PEFR variability <20%
Step 2: Mild persistent	Symptoms >2 per week but <1 per day Exacerbations may affect activity	>2 per month	FEV_1 or PEFR ≥80% predicted PEFR variability 20%–30%
Step 3: Moderate persistent	Daily symptoms Daily use of inhaled short-acting $ß_2$-agonist Exacerbations may affect activity Exacerbations ≥2 per week; may last days	>1 per week	FEV_1 or PEFR >60%–<80% predicted PEFR variability >30%
Step 4: Severe persistent	Continual symptoms Limited physical activity Frequent exacerbations	Frequent	FEV_1 or PEFR <60% predicted PEFR variability >30%

** Adapted from NHLBI Expert Panel Report. The presence of one of the features of severity is sufficient to place a patient in that category. Assign patient to the most severe grade in which any feature occurs. The characteristics noted in this Table are general and may overlap because of the high variability of asthma and because an individual's classification may change over time. PEFR = peak expiratory flow rate.*

† Patients at any level of severity can have mild, moderate, or severe exacerbations. Some patients with intermittent asthma experience severe, life-threatening exacerbations separated by long periods of normal lung function and no symptoms.

What comorbid conditions and alternative diagnoses should clinicians consider in patients with suspected asthma?

The differential diagnosis of asthma includes the following conditions: COPD, interstitial lung disease, vocal cord dysfunction, congestive heart failure, medication-induced cough, bronchiectasis, pulmonary infiltration with eosinophilia syndromes, obstructive sleep apnea, mechanical airway obstruction, cystic fibrosis, and pulmonary hypertension. Clinicians should consider one of these alternative diagnoses when asthma is difficult to control or if the patient has atypical signs and symptoms. These conditions can also coexist in a patient who has asthma.

An important difference between asthma and COPD is the history of smoking. Although 30% of patients with asthma in the United States smoke, COPD, manifested by chronic bronchitis and emphysema, often occurs in older persons with a substantial history of cigarette smoking. Patients with COPD also do not demonstrate reversibility with bronchodilators on pulmonary function testing.

Lung imaging with radiography or computed tomography is helpful in identifying bronchiectasis or lung masses. Echocardiography can help to identify cardiovascular disorders, including ischemic heart disease, ventricular dysfunction, and pulmonary hypertension. Flow-volume loops and direct visualization of the larynx during an acute episode are useful in evaluating patients for vocal cord paralysis.

Chronic cough and dyspnea or recurrent wheezing are common signs of COPD, vocal cord dysfunction, cystic fibrosis, obstructive sleep apnea, Churg-Strauss syndrome, allergic bronchopulmonary aspergillosis, interstitial lung disease, bronchiectasis, congestive heart failure, and pulmonary hypertension, or may be side effects of

17. Irwin RS, Curley FJ, French CL. Difficult-to-control asthma. Contributing factors and outcome of a systematic management protocol. Chest. 1993;103:1662-9. [PMID: 8404082]
18. Althuis MD, Sexton M, Prybylski D. Cigarette smoking and asthma symptom severity among adult asthmatics. J Asthma. 1999;36:257-64. [PMID: 10350222]
19. Weiss ST, Utell MJ, Samet JM. Environmental tobacco smoke exposure and asthma in adults. Environ Health Perspect. 1999;107 Suppl 6:891-5. [PMID: 10592149]
20. Ostro BD, Lipsett MJ, Mann JK, Wiener MB, Selner J. Indoor air pollution and asthma. Results from a panel study. Am J Respir Crit Care Med. 1994;149:1400-6. [PMID: 8004290]

Measures to Reduce Dust Mite and Other Environmental Allergen and Irritant Exposure

- Use air conditioning to maintain humidity <50%
- Remove carpets
- Limit fabric household items, such as upholstered furniture, drapes, and soft toys
- Use impermeable covers for mattresses and pillows
- Launder bedding weekly in water at least 130°F
- Ensure adequate ventilation—may be the only measure necessary for dust mite control in dry climates
- Exterminate to reduce cockroaches
- Remove cats from the home
- Reduce dampness in the home
- Avoid wood-burning or unvented gas fireplaces or stoves
- Avoid tobacco smoke

medications. Evidence shows that difficult-to-control asthma may be a result of comorbid conditions and that standardized evaluation of patients for comorbidity was associated with improved asthma control (17).

When should primary care clinicians consider referring patients with suspected asthma to specialists for diagnosis?

Consultation with a pulmonologist should be considered before ordering provocative pulmonary function testing because testing is time- and labor-intensive, requiring skilled performance and interpretation. Patients presenting with atypical symptoms, who have abnormal chest radiographs or unusual manifestations of the disease, or who display suboptimal response to therapy may benefit from referral to a pulmonologist. Referral to an allergist may be helpful for patients with asthma that seems to have an allergic component.

Diagnosis... A careful history focusing on the nature and timing of symptoms (wheezing, dyspnea, cough, chest tightness) and potential triggers is essential to the diagnosis of asthma. Moderate-quality evidence supports the use of spirometry in assessment of all adult patients and older children suspected of having asthma. However, normal spirometry does not definitively rule out asthma. Clinicians should consider provocative pulmonary testing for patients with normal spirometry but characteristic symptoms and no evidence of alternative diagnoses.

CLINICAL BOTTOM LINE

Treatment

What advice about reducing allergen exposure should clinicians give patients?

Avoidance of triggers is the cornerstone of nonpharmacologic therapy of asthma. Clinicians should question the patient about triggers and provide strategies to diminish exposure to them (see box). Since many patients with asthma are atopic, reducing exposure to allergens can improve outcomes. Other common triggers of asthma include aspirin, nonsteroidal anti-inflammatory drugs, and sulfites in food preservatives. Limiting exposure to triggers is difficult to implement or sustain in some patients; however, in most cases such triggers are dose-dependent, so even modest remediation can be beneficial.

The NHLBI Expert Panel Report recognized environmental smoke exposure as a common cause of asthma exacerbations (2), and several studies have impugned active and passive cigarette smoking as a cause of decreasing lung function in adult asthma (18, 19).

One study considered associations between indoor air pollutants and symptoms in 164 adults with asthma and found an increase in days of restricted activity (odds ratio [OR], 1.61 [95% CI, 1.06 to 2.46]) and greater likelihood of increased asthma symptoms in patients exposed to a smoker at home (OR, 2.05 [CI, 1.79 to 2.40]) (20).

What evidence supports the use of indoor air–cleaning devices for patients with asthma?

Given the recognition that environment plays a critical role in airway hygiene, it may seem logical that indoor air-cleaning devices are beneficial. However, there is little evidence to suggest that HEPA filters, air duct cleaning, or dehumidifiers control asthma. Humidifiers may actually increase allergen levels and must be cleaned often. Keeping

21. Institute of Medicine Committee on the Assessment of Asthma and Indoor Air. Executive summary. In: Clearing the Air: Asthma and Indoor Air Exposures. Washington, DC: National Academy Pr; 2000.
22. National Heart, Lung, and Blood Institute, National Asthma Education and Prevention Program. Expert Panel Report: Guidelines for the Diagnosis and Management of Asthma—Update on Selected Topics 2002. Bethesda MD: US Department of Health and Human Services, National Institutes of Health, 2002; Publication 02-5075.
23. Aronson N, Lefevre F, Piper M, Management of Chronic Asthma. Summary, Evidence Report/Technology Assessment Number 44. Rockville, MD: Agency for Healthcare Research and Quality; 2001. AHRQ Publication 01-E044.

household humidity below 50% with dehumidifiers or air conditioners reduces dust mites and mold (21).

A multidisciplinary committee convened by the Institute of Medicine reviewed available evidence concerning the impact of ventilation and air cleaning on asthma (21). Although they concluded that particle air cleaning may reduce symptoms in certain situations, evidence is inadequate to broadly recommend air cleaning for patients with asthma.

How should clinicians select from among available drug therapy for asthma?

Table 3 summarizes drugs available to treat asthma. Table 4 presents a stepwise approach to using these drugs to maximize control of symptoms (2, 22).

Clinicians should tailor drug therapy to the severity of asthma (Table 2). Stepwise therapy consists of agents for acute relief of symptoms (rescue therapy) and for long-term control. Rescue therapy is critically important regardless of asthma severity. Patients with persistent symptoms require long-term control in addition to rescue therapy. If control is poor, stepping up to more intense therapy is indicated. If symptoms are well-controlled, stepping down to less intensive therapy is indicated.

Clinicians should review therapy every 1 to 6 months, depending on asthma severity. Asthma is a chronic disease that often requires long-term therapy. Given the complexity of airway inflammation, multiple drugs with different actions against the various aspects of the inflammatory response are often necessary.

Rescue Therapy

Patients with mild intermittent asthma may only need a quick relief medication (short-acting β-agonists) on an as-needed basis. Short-acting β-agonists are the drugs of choice for reversal of acute bronchospasm and are safe and well-tolerated. Patients with persistent asthma (mild, moderate, or severe) should also receive a short-acting β-agonist and advice to keep the medication readily available for relief of acute symptoms.

Long-Term Controller Therapy

Patients with mild, moderate, or severe persistent asthma have abnormal baseline pulmonary function and require long-term controller therapy. Patients with mild persistent asthma should receive 1 long-term controller medication, usually a low-dose inhaled corticosteroid.

Compared with patients with mild intermittent asthma, patients with mild persistent asthma are more prone to underlying inflammation and disease exacerbations. Low-dose inhaled corticosteroids have been shown to reduce bronchial hyperresponsiveness, reduce rescue β-agonist use, and control symptoms. Secondary alternatives to inhaled corticosteroids are leukotriene-receptor antagonist medications (e.g., montelukast, zafirlukast) or cromolyn.

Patients with moderate persistent asthma will probably require 1 or 2 long-term controller medications in addition to short-acting rescue therapy. The therapy of choice in this group includes low-dose inhaled corticosteroids and a long-acting β-agonist or a moderate dose of a single long-term controller medication. Evidence suggests that patients who remain symptomatic while taking moderate doses of inhaled corticosteroids benefit from the addition of a long-acting bronchodilator such as theophylline, salmeterol, or formoterol. The additive effect of the long-acting bronchodilator improves lung physiology, decreases use of rescue β-agonists, and reduces symptoms better than doubling the dose of an inhaled corticosteroid (23–26). However, there is little evidence to guide the best choice of combinations. Clinicians and patients must weigh the reduced risk for adverse effects of steroids against the use of more complicated regimens. It is

Evidence is inadequate to broadly recommend air cleaning devices for patients with asthma.

24. Greening AP, Ind PW, Northfield M, Shaw G. Added salmeterol versus higher-dose corticosteroid in asthma patients with symptoms on existing inhaled corticosteroid. Allen & Hanburys Limited UK Study Group. Lancet. 1994;344:219-24. [PMID: 7913155]
25. Ukena D, Harnest U, Sakalauskas R, Magyar P, Vetter N, Steffen H, et al. Comparison of addition of theophylline to inhaled steroid with doubling of the dose of inhaled steroid in asthma. Eur Respir J. 1997;10:2754-60. [PMID: 9493656]
26. Woolcock A, Lundback B, Ringdal N, Jacques LA. Comparison of addition of salmeterol to inhaled steroids with doubling of the dose of inhaled steroids. Am J Respir Crit Care Med. 1996;153:1481-8. [PMID: 8630590]

Table 3. Drug Treatment for Asthma

Class/Agent	*Mechanism of Action*	*Benefits*	*Side Effects*	*Notes*
Short-acting ß-agonists: Albuterol Metaproterenol Terbutaline Pirbuterol	Relaxes bronchial smooth muscle, improves airflow	Fastest improvement in airflow physiology of all anti-asthma medications	Tachycardia, palpitations, tremors, hypokalemia	Should be carried by all patients with asthma at all times. Drug class of choice for acute bronchospasm. Use only as needed. Effective at preventing symptoms of asthma when used before exercise. Assessment of quantity of ß-agonist use may identify patients who require a "step-up" in therapy. Use of >1 canister during a 1-month period suggests inadequate control. Oral preparations available, but inhaled is preferred due to better side effect profile.
Inhaled corticosteroids: Beclomethasone dipropionate Beclomethasone hydrofluoroalkane Budesonide Flunisolide Fluticasone propionate Triamcinolone acetonide Ciclesonide Mometasone	Anti-inflammatory, blocks late reaction to allergen, and reduces airway hyperresponsiveness	Improved airflow physiology, reduced need for rescue medications (short-acting ß-agonists), prevents exacerbations and hospitalizations	Local: cough, dysphonia, and thrush. Systemic: cortisol suppression, adrenal suppression, potential osteoporosis, cataracts, glaucoma	Each type of inhaled corticosteroid has a different profile in terms of dosing potency and possible risks for any of the known side effects. Drug deposition in the lower airway and systemic absorption and toxicity are conditioned by the drug and preparation, inhalation technique, and use of a spacing chamber. There is little information on how to monitor effectiveness and toxicity of inhaled corticosteroids, especially considering the varying degrees of seasonal inflammations or following differing stimuli/exposures. Inhaled corticosteroids are the most potent and effective anti-inflammatory medications available for asthma.
Long-acting inhaled ß-agonists: Salmeterol Formoterol	Smooth muscle relaxation	Improved a.m. peak flow, improved nocturnal symptoms, effective in preventing symptoms of exercise-induced asthma for up to 12 hours after a single dose	Tachycardia, skeletal muscle tremor, prolongation of QT interval in overdose	Use only in conjunction with anti-inflammatory therapy. Protection against exercise-induced symptoms may decrease over time. Salmeterol has slower onset and both have longer duration of action compared with short-acting ß-agonists. May provide more effective symptom control when added to standard doses of inhaled corticosteroids compared to increasing corticosteroid dosage. The FDA has warned that these agents may increase the chances of a severe asthma episode. This seems more likely in blacks.
Combined fixed-agent controllers: Fluticasone and salmeterol Budesonide and formoterol	Anti-inflammatory moiety blocks late reaction to allergen, and reduces airway hyperresponsiveness, and long-acting ß-agonist leads to smooth muscle relaxation	Improved airflow physiology, reduced need for short acting ß-agonists, prevents exacerbations and hospitalizations; improved a.m. peak flow, improved nocturnal symptoms	Dysphonia, thrush, nausea, headaches	Should not be initiated in patients during rapidly deteriorating or potentially life-threatening episodes of asthma. Do not use in conjunction with inhaled long-acting ß-agonists. Combined preparations prevent the use of long-acting ß-agonists without inhaled corticosteroids.
Leukotriene modifiers: Montelukast Zafirlukast Zileuton	Work by inhibition of synthesis or antagonism of receptor site for cysteinyl leukotrienes	Improvements in symptoms and pulmonary function, decreased exacerbation rate, reduced need for rescue ß-agonist	Transient elevation in liver enzymes occurs with Zileuton and mandates monitoring of liver enzymes with initiation of therapy; there is controversy over possible link with Churg-Strauss angiitis (causation has not been established)	Oral tablets may be easier to use than inhaled medications and may enhance compliance; therapeutic benefits are less than those of inhaled corticosteroids. May be of particular benefit in patients with aspirin intolerance and/or nasal polyps. May allow for safe reduction in inhaled and oral corticosteroids. May be an alternative to increasing dose of inhaled corticosteroid.
Theophylline	Smooth muscle relaxation, may have secondary effects of inhibiting airway inflammation and enhancing diaphragm contractility	Modest improvement in expiratory flow rates	Dose-related acute toxicities include tachycardia, nausea vomiting, tachyarrhythmias (SVT), CNS stimulation, headache, seizures Sometimes adverse effects are seen at therapeutic levels	Studies show a benefit in the addition of theophylline to inhaled corticosteroids

Table 3. Drug Treatment for Asthma (continued)

Class/Agent	*Mechanism of Action*	*Benefits*	*Side Effects*	*Notes*
Mast cell stabilizers: Cromolyn Nedocromil	Anti-inflammatory, blocks early and late reaction to allergens, and stabilizes mast cell membranes; inhibits eosinophil activation and mediator release	Improved airflow physiology, reduced need for rescue medications (short-acting ß-agonists), prevents exacerbations	Cromolyn: no significant side effects Nedocromil: 15%–20% of users complain of unpleasant taste	The therapeutic response to this class of drugs is less predictable than to corticosteroids, but they continue to be used due to their safety profile
Systemic corticosteroids: Prednisone Prednisolone Methylprednisolone Triamcinolone	Anti-inflammatory, blocks late reaction to allergen, and reduces airway hyperresponsiveness	Improved airflow physiology, reduced need for rescue medications (short-acting ß-agonists), prevents exacerbations and hospitalizations	Short-term: increased appetite and weight gain, fluid retention, reversible abnormalities in glucose metabolism, mood alterations Long-term: dermal thinning, cortisol suppression, adrenal suppression, hypertension, diabetes mellitus, osteoporosis, avascular necrosis of femoral head, cataracts, glaucoma	Most effective medication for severe exacerbations and long-term control for patients with severe persistent asthma who are otherwise uncontrolled. Always seek lowest possible effective dose. Patients on corticosteroids (either daily or ≥2 corticosteroid prescriptions for 5–10 days/yr) and undergoing surgery or with acute severe illness should be assessed for adrenal reserve or treated presumptively with short-term systemic corticosteroid. Studies show that it is safe to give a short course of oral corticosteroids (7–10 days) without tapering.
Anticholinergic agents: Ipratropium bromide Glycopyrrolate otropium	Bronchodilation mediated by antagonism of muscarinic receptors of airway smooth muscle	Improved airflow physiology	Blurred vision if contact with eyes, dry mouth and respiratory symptoms	Treatment of choice in ß-blocker induced bronchospasm; may give added bronchodilation to ß-agonists. Meta-analysis of the use of ipratropium bromide in the treatment for acute severe asthma shows that there is a modest physiologic benefit in the addition of ipratropium to albuterol, with negligible risk of adverse side effects. Tiotropium has been suggested as an alternative to long-acting ß-agonists, but suitable effectiveness studies are lacking.
Intravenous magnesium sulfate	Smooth muscle relaxation	Bronchodilatation in acute severe asthma failing to respond to nebulized bronchodilators-	Minor effects; flushing, lethargy, nausea, or local reaction at the IV site	
Omalizumab	A monoclonal antibody that binds to IgE used in patients aged 12 years or older with moderate to severe persistent asthma, proven IgE-mediated sensitivity to perennial aeroallergens, and poor response to standard treatment. Binding of IgE by monoclonal antibody inhibits binding to high-affinity IgE receptors on mast cells and basophils	Reduction in exacerbations in patients with severe persistent asthma on the best available therapy	The main danger is anaphylaxis. Injections should be administered by trained personnel, and patients should be observed for 2 hours after every injection. Anaphylaxis has been reported up to 24 hours after injection, and patients receiving omalizumab treatment should be fully prepared to begin treatment for anaphylaxis with an epinephrine autoinjector	Anaphylaxis may occur after any dose of omalizumab (including the first dose), even if there was no adverse reaction to the first dose. The symptoms and signs of anaphylaxis include bronchospasm, hypotension, syncope, urticaria, and angioedema of the throat or tongue. In the major trials, there was a small increase in new or recurrent cancer compared to the control group

**Readers can access detailed information on dosing in PIER at http://pier.acponline.org/physicians/diseases/d146/drug.tx/d146-s7.html. CNS = central nervous system; FDA = Food and Drug Administration*

unclear whether controlling the disease with high-dose inhaled corticosteroids or moderate-dose inhaled corticosteroids plus a long-acting bronchodilator results in a better long-term outcome.

In a 12-week, randomized, controlled trial of 447 patients who remained symptomatic on treatment with inhaled corticosteroids, a dry-powder inhaler containing salmeterol and fluticasone was more effective in improving physiologic endpoints, reducing rescue therapy use, and reducing exacerbations

Table 4. Stepwise Approach for Managing Asthma in Adults

STEP Classification	*Long-Term Control*	*Quick Relief*	*Education*
Step 1: Mild intermittent	No daily medication needed	Short acting bronchodilator: inhaled $ß_2$-agonists* as needed for symptoms	Teach basic facts about asthma; teach inhaler/spacer/holding chamber technique; discuss roles of medications; develop self-management plan; develop action plan for when to take rescue medications, especially for patients with a history of severe exacerbations; discuss appropriate environmental control measures to avoid exposure to known allergens and irritants
Step 2: Mild persistent	One daily medication: • Anti-inflammatory*: either inhaled corticosteroid (low doses) or cromolyn* or nedocromil* (children usually begin with a trial of cromolyn or nedocromil) • Sustained-release theophylline to serum concentration of 5-15 µg/mL is an alternative, but not preferred, therapy. • Montelukast, zafirlukast, or zileuton may also be considered for patients age 12 and older, although their position in therapy is not fully established	Short-acting bronchodilator: inhaled $ß_2$-agonists* as needed for symptoms	Step 1 actions, plus teach self-monitoring; refer to group education if available; review and update self-management plan
Step 3: Moderate persistent	Preferred treatment: • Low-to-medium dose inhaled corticosteroids and long-acting inhaled $ß_2$-agonists. Alternative treatment: Increase inhaled corticosteroids within medium-dose range OR • Low-to-medium dose inhaled corticosteroids and either leukotriene modifier or theophylline. OR • If needed (particularly in patients with recurring severe exacerbations): Increase inhaled corticosteroids within medium-dose range, and add long-acting inhaled $ß_2$-agonists. Alternative treatment: Increase inhaled corticosteroids to medium-dose range, and add either leukotriene modifier or theophylline	Short acting bronchodilator: inhaled $ß_2$-agonists* as needed for symptoms	Step 1 actions, plus teach self-monitoring; refer to group education if available; review and update self-management plan
Step 4: Severe persistent	Preferred treatment: High-dose inhaled corticosteroids AND Long-acting inhaled $ß_2$-agonists AND, if needed, Corticosteroid tablets or syrup long-term (2 mg/kg/d, generally do not exceed 60 mg/d). (Make repeated attempts to reduce systemic corticosteroids and maintain control with high-dose inhaled corticosteroids.)	Short-acting bronchodilator: inhaled $ß_2$-agonists* as needed for symptoms.	Step 2 and 3, plus refer to individual education/ counseling

**Intensity of treatment depends on severity of exacerbation. Use of short-acting inhaled $ß_2$-agonists on a daily basis, or increasing use, indicates the need for additional long-term control therapy*

than was the addition of montelukast to the inhaled corticosteroid fluticasone (27).

Long-acting β-agonists may help improve asthma symptoms, but they may also increase risks for adverse outcomes. Patients started on these medications should be followed closely.

A meta-analysis of 19 randomized, controlled trials found that, compared with placebo, long-acting ß-agonists increased severe exacerbations requiring hospitalization (OR, 2.6 [CI, 1.6 to 4.3]), life-threatening exacerbations (OR, 1.8 [CI, 1.1 to 2.9]), and asthma-related deaths (OR, 3.5 [CI, 1.3 to 9.3]; risk difference, 0.07%) (28). Risks were similar for salmeterol and formoterol and in children and adults. Several trials did not report information about potential harms, and the number of reported deaths was small. Black patients and patients not using inhaled corticosteroids seemed to be at high risk for these outcomes. These results suggest that long-acting ß-agonists should not be used alone in asthma (28).

27. Nelson HS, Busse WW, Kerwin E, Church N, Emmett A, Rickard K, et al. Fluticasone propionate/salmeterol combination provides more effective asthma control than low-dose inhaled corticosteroid plus montelukast. J Allergy Clin Immunol. 2000;106:1088-95. [PMID: 11112891]

Patients with severe persistent asthma may require 3 controller medications to adequately control symptoms. Patients with this level of disease are extremely prone to exacerbations and have profound underlying inflammation. Direct comparisons of high-dose inhaled corticosteroids to leukotriene-receptor modifiers (such as montelukast) revealed that the inhaled corticosteroids were more effective. The addition of montelukast to the regimen of a patient requiring high-dose inhaled corticosteroids, however, allowed a significant reduction in the dose of the inhaled corticosteroid while maintaining asthma control (29).

In a randomized, controlled study of patients with inadequate symptom control despite low- to moderate-dose inhaled corticosteroid, the addition of montelukast improved FEV_1, daytime symptoms and nocturnal awakenings (30).

A systematic review of trials comparing the addition of daily leukotriene-receptor antagonists or long-acting ß-agonists to inhaled corticosteroids in patients with severe asthma concluded that long-acting ß-agonists were better than leukotriene antagonists in preventing the need for rescue therapy and systemic steroids and improved lung function and symptoms (31, 32)

Omalizumab is a monoclonal antibody that binds to IgE that has been shown to reduce exacerbations in patients with severe persistent asthma despite best available therapy (33). However, severe anaphylaxis has been reported up to 24 hours after injection. Clinicians should view the drug as an option only in carefully selected cases of severe persistent asthma in patients with proven IgE-mediated sensitivity to perennial aeroallergens, and failure of other therapeutic options.

What therapeutic options are effective for patients with exercise-induced asthma?

In some patients, exercise exacerbates asthma. Symptoms often occur with vigorous exercise in cold, dry air. Patients who have more than 2 episodes of exercise-induced asthma per week are candidates for intervention. Patients who have normal baseline pulmonary function but experience exercise-induced symptoms can be treated effectively with albuterol, cromolyn sodium, or nedocromil 15 to 30 minutes before exercise.

If exercise-induced symptoms persist, addition of long-acting bronchodilators or leukotriene antagonists may be helpful. Recent evidence suggesting that monotherapy with long-acting bronchodilators may cause adverse outcomes in asthma cautions against using these agents as monotherapy in exercise-induced asthma (28, 34). Despite these concerns, evidence clearly suggests that formoterol or salmeterol is more effective than placebo in preventing exercise-induced bronchoconstriction (35, 36). In a study of patients with mild stable asthma, once-daily treatment with montelukast protected against exercise-induced bronchospasm (37).

The clinician should consider exercise-induced asthma in the context of the patient's overall therapy. Many patients who present with putative exercise-induced asthma may have abnormal pulmonary function tests at baseline. Such patients should be treated according to the NHLBI Expert Panel Report 2 regimen (2).

When should primary care clinicians refer patients with asthma to a specialist for treatment?

Although definitive evidence about the effect of specialty care on asthma outcomes is not available, according to consensus recommendations referral to a specialist may be useful in the following clinical situations:

- History of life-threatening exacerbations
- Atypical signs and symptoms
- Severe persistent asthma
- Need for continuous oral corticosteroids or high-dose inhaled steroids or more than 2 courses of oral steroids in a 1-year period

28. Salpeter SR, Buckley NS, Ormiston TM, Salpeter EE. Meta-analysis: effect of long-acting beta-agonists on severe asthma exacerbations and asthma-related deaths. Ann Intern Med. 2006;144:904-12. [PMID: 16754916]
29. Löfdahl CG, Reiss TF, Leff JA, Israel E, Noonan MJ, Finn AF, et al. Randomised, placebo controlled trial of effect of a leukotriene receptor antagonist, montelukast, on tapering inhaled corticosteroids in asthmatic patients. BMJ. 1999;319:87-90. [PMID: 10398629]
30. Laviolette M, Malmstrom K, Lu S, Chervinsky P, Pujet JC, Peszek I, et al. Montelukast added to inhaled beclomethasone in treatment of asthma. Montelukast/Beclomethasone Additivity Group. Am J Respir Crit Care Med. 1999;160:1862-8. [PMID: 10588598]
31. Coté J, Cartier A, Robichaud P, Boutin H, Malo JL, Rouleau M, et al. Influence on asthma morbidity of asthma education programs based on self-management plans following treatment optimization. Am J Respir Crit Care Med. 1997;155:1509-14. [PMID: 9154850]
32. Ducharme FM, Lasserson TJ, Cates CJ. Long-acting √ü‚-agonists versus anti-leukotrienes as add-on therapy to inhaled corticosteroids for chronic asthma. Cochrane database Syst Rev. 2006:CD003137. [PMID: 17054161].
33. Humbert M, Beasley R, Ayres J, Slavin R, Hebert J, Bousquet J, et al. Benefits of omalizumab as add-on therapy in patients with severe persistent asthma who are inadequately controlled despite best available therapy (GINA 2002 step 4 treatment): INNOVATE. Allergy. 2005;60:309-16. [PMID: 15679715]

- Comorbid conditions that complicate asthma diagnosis or treatment
- Need for provocative testing or immunotherapy
- Problems with adherence or allergen avoidance
- Unusual occupational or other exposures.

Whether to consult an allergist or pulmonologist should reflect local availability and consideration of the predominant comorbid conditions and complicating features in asthma. For example, a patient with sleep apnea and asthma may benefit from a pulmonary consultation, whereas the patient who has asthma with an atopic component may benefit from referral to an allergist.

Factors Associated with Poor Outcomes of Asthma Exacerbations

- Prior intubation
- Multiple asthma-related exacerbations
- Emergency room visits for asthma in the previous year
- Nonuse or low adherence to inhaled corticosteroids
- History of depression, substance abuse, personality disorder, unemployment, or recent bereavement

When is hospitalization indicated for a patient with asthma?

Patients who have a sustained response to treatment in outpatient settings do not need to be hospitalized if they understand the importance of continued anti-inflammatory therapy and close follow-up. The decision to hospitalize a patient with asthma should consider patient characteristics, severity of disease, and initial response to short-term therapy. Patients with an incomplete response to therapy during an exacerbation (PEFR >50% but <70% than patient's best or of the predicted value) may need hospitalization. When posttreatment PEFR remains <50% of the predicted value, intensive care unit admission may be warranted. However, data are insufficient to support the idea that adequate oxygen saturation and PEFR at the time of emergency department discharge predict a good outcome.

In a prospective cohort study of adults presenting with asthma to urban emergency departments in the United States, the PEFR of those who had a relapse did not significantly differ from those who did not have a relapse after discharge from the emergency department. However, such historical features as emergency department or urgent care visits (OR, 1.3 per 5 visits), use of a home nebulizer (OR, 2.2), multiple triggers (OR, 1.1 per trigger), and longer duration of symptoms (OR, 2.5 for 1 to 7 days) did predict relapse (38).

What factors identify patients with asthma at high risk for fatal or near-fatal events during an exacerbation?

Historical factors reflect the risk for fatal and near-fatal asthma-related events and should lower the threshold for hospitalization of a person when these factors are present. Such factors include asthma history, socioeconomic characteristics, and comorbid conditions (see Box).

How often should clinicians see patients with asthma for routine follow-up?

No definitive studies are available to guide the frequency of asthma follow-up, but consensus suggests that for patients with newly diagnosed asthma, 2 to 4 visits during the 6 months after diagnosis can help to establish and reinforce the patient's basic knowledge and management skills. For patients with asthma who have shown maximum improvement in pulmonary function and have minimal to no related symptoms, the NHLBI Expert Panel Guide suggests routine follow-up every 1 to 6 months with annual pulmonary function tests (2); however, evidence documenting the benefit of this strategy is limited. The Report also suggests follow-up within 7 days for patients discharged from the hospital and within 10 days for patients treated as outpatients for an exacerbation. Studies have shown that relapse occurs in about 1% of patients per day until the follow-up visit (38–40).

34. SMART Study Group. The Salmeterol Multicenter Asthma Research Trial: a comparison of usual pharmacotherapy for asthma or usual pharmacotherapy plus salmeterol. Chest. 2006;129:15-26. [PMID: 16424409]
35. Nelson JA, Strauss L, Skowronski M, Ciufo R, Novak R, McFadden ER Jr. Effect of long-term salmeterol treatment on exercise-induced asthma. N Engl J Med. 1998;339:141-6. [PMID: 9664089]
36. Nightingale JA, Rogers DF, Barnes PJ. Comparison of the effects of salmeterol and formoterol in patients with severe asthma. Chest. 2002;121:1401-6. [PMID: 12006420]
37. Leff JA, Busse WW, Pearlman D, Bronsky EA, Kemp J, Hendeles L, et al. Montelukast, a leukotriene-receptor antagonist, for the treatment of mild asthma and exercise-induced bronchoconstriction. N Engl J Med. 1998;339:147-52. [PMID: 9664090]
38. Emerman CL, Woodruff PG, Cydulka RK, Gibbs MA, Pollack CV Jr., Camargo CA Jr. Prospective multicenter study of relapse following treatment for acute asthma among adults presenting to the emergency department. MARC investigators. Multicenter Asthma Research Collaboration. Chest. 1999;115:919-27. [PMID: 10208187]

Treatment... Patients should avoid asthma triggers. While air conditioners or dehumidifiers may be helpful, indoor air-cleaning devices are of unclear utility. All patients with asthma should have short-acting β-agonists available for relief of acute symptoms. For patients with persistent asthma, treatment with long-term controller medications should begin with low-dose inhaled corticosteroids and be stepped up to higher doses and/or additional agents according to asthma severity. Patients with severe persistent asthma may need as many as 3 long-term controller medications.

CLINICAL BOTTOM LINE

Practice Improvement

What do professional organizations recommend regarding the care of patients with asthma?

Many of the recommendations provided in this overview are from a guideline developed by the NHLBI that was most recently updated in 2002 (22). The guidelines were approved by the 40 organizations that comprise the National Asthma Education and Prevention Program. The document covers pathogenesis, medications, monitoring, and prevention and is available free at www.nhlbi.nih.gov/guidelines/asthma/asthgdln.htm.

Numerous other organizations have developed recommendations related to the care of patients with asthma, including the American Academy of Asthma, Allergy and Immunology (www.aaaai.org); the American Lung Association (www.lungusa.org); and the Asthma and Allergy Foundation of America (www.aafa.org). These organizations also provide demographically and culturally sensitive educational programs and teaching tools.

What is the role of patient education in optimizing the outcome of asthma care?

Asthma is a paradigm illness for patient self-management because of its intermittent and unpredictable nature. Patients and family members can recognize changes and initiate specific actions to minimize exacerbations. Clinicians should include asthma education as part of each office visit, and formal asthma education programs may be particularly helpful for patients who have had asthma hospitalizations, emergency department visits, or frequent exacerbations. Important elements of asthma education include basic information, the role of medications, inhaler and peak flow meter skills, environmental control measures, and appropriate use of rescue medications. Demographically and culturally appropriate educational materials can be used as an adjunct to one-on-one asthma education. Because many patients use metered-dose inhalers improperly, all patients should receive instruction on proper use.

Clinicians should develop individualized self-management plans for all patients, taking into consideration underlying disease severity and the patient's willingness and ability to manage the illness. For patients with mild disease, clinicians should consider providing a simple self-management plan that provides information on how to handle exacerbations, including health care contacts in case of emergency. For patients with moderate-to-severe disease, provide a self-management plan that incorporates a daily diary and a detailed written action plan with specific objective and subjective

39. McCarren M, McDermott MF, Zalenski RJ, Jovanovic B, Marder D, Murphy DG, et al. Prediction of relapse within eight weeks after an acute asthma exacerbation in adults. J Clin Epidemiol. 1998;51:107-18. [PMID: 9474071]
40. Rowe BH, Bota GW, Fabris L, Therrien SA, Milner RA, Jacono J. Inhaled budesonide in addition to oral corticosteroids to prevent asthma relapse following discharge from the emergency department: a randomized controlled trial. JAMA. 1999;281:2119-26. [PMID: 10367823]
41. Effectiveness of routine self monitoring of peak flow in patients with asthma. Grampian Asthma Study of Integrated Care (GRASSIC). BMJ. 1994;308:564-7. [PMID: 8148679]
42. Charlton I, Charlton G, Broomfield J, Mullee MA. Evaluation of peak flow and symptoms only self management plans for control of asthma in general practice. BMJ. 1990;301:1355-9. [PMID: 2148702]

Ambulatory Care Quality Alliance Performance Measures for Asthma

- Percentage of individuals who were identified as having persistent asthma during the 1 year before the measurement year and who were appropriately prescribed asthma medications (e.g., inhaled corticosteroids) during the measurement year.
- Percentage of individuals with mild, moderate, or severe persistent asthma who were prescribed either the preferred long-term control medication (inhaled corticosteroid) or an acceptable alternative treatment.

Center for Medicare & Medicaid Services (CMS) Asthma Quality Measures

- Percentage of patients aged 5 to 40 years with a diagnosis of mild, moderate, or severe persistent asthma who were prescribed either inhaled corticosteroid or an acceptable alternative.
- Percentage of patients aged 5 to 40 years with a diagnosis of asthma who were evaluated during at least one office visit within 12 months for the frequency (numeric) of daytime nocturnal asthma symptoms.

markers for self-directed change in therapy.

Should all patients with asthma receive peak flow meters?

The precision of patients and physicians in estimating the degree of airflow obstruction based on symptoms alone varies greatly, so objective measurement of expiratory flow rates could in theory be useful to guide therapeutic strategies. However, studies that have randomly assigned patients to action plans that incorporate PEFR have not shown major improvements compared with action plans based on symptoms alone (41, 42).

Clinicians should ensure that all patients with persistent moderate-to-severe asthma have a peak flow meter at home and know how to use it. If patients are unwilling to measure peak flow, provide instruction in symptom-based monitoring.

Do U.S. stakeholders consider asthma care when evaluating the quality of care a physician delivers?

In April 2005, The Ambulatory Care Quality Alliance (AQA) released a set of 26 health care quality indicators for clinicians, consumers, and health care purchasers to use in quality improvement efforts, public reporting, and pay-for-performance programs (www.ahrq.gov/qual/aqastart.htm). In May 2005, the Centers for Medicare & Medicaid Services (CMS) endorsed the development of these indicators. Of the 26 AQA indicators, 2 focus on asthma care (see the Box).

As part of CMS's Physician Quality Reporting Initiative, physicians who successfully report a designated set of quality measures on claims for services provided July 1 to December 31, 2007, may earn a bonus payment. See the Box for the 2 CMS measures related to asthma (www.cms.hhs.gov/specifications_2007-02-04.pdf).

in the clinic

Tool Kit

Asthma

http://PIER.acponline.org
Asthma module of PIER, an electronic decision support resource designed for rapid access to information at the point of care.

http://pennhealth.com/ency/presentations/100200_1.htm
Tutorial on proper use of metered dose inhalers.

http://pier.acponline.org/qualitym/asm.html
Tool to assist clinicians in developing strategies to improve adherence to the AQA asthma performance measures.

www.annals/intheclinic/tools
Download copies of the patient information sheet that appears on the following page for duplication and distribution to your patients.

THINGS PEOPLE SHOULD KNOW ABOUT ASTHMA

Asthma causes a squeezing of the muscle in the walls of the tubes (airways, bronchi) that bring air to the lungs. Breathing becomes difficult when this happens.

Web Sites with Good Information about Asthma

MedlinePLUS
www.nlm.nih.gov/medlineplus/asthma.html

American Lung Association
www.lungusa.org

How to Use a Metered Dose Inhaler

Inhalers deliver a specific dose of medicine to the lungs in a spray form.

1. Take off the cap and shake the inhaler hard.
2. Breathe out all the way.
3. Hold the inhaler about 2-fingers width from your mouth.
4. Start to breath in slowly through your mouth as you press down on the inhaler once and keep breathing in slowly until you can't breathe in any more.
5. Hold your breath and count to 10 slowly.
6. Repeat steps 1 to 5 if your doctor has prescribed more than 1 puff of medicine, wait about 1 minute between puffs.

HEALTH TiPS* WHAT YOU CAN DO

Asthma makes you cough and wheeze and can make it hard to breathe.

Here's what you can do to feel better.

Stay away from what makes your asthma worse:

- Dust
- Smoke
- Animals
- Cold or dry air

Don't smoke and stay away from people who do

Asthma-proof your home:

- Get special mattress and pillow covers
- Get rid of old carpets and drapes
- Use air conditioners and dehumidifiers

Use your medicines the right way:

- Take medicines that prevent attacks every day
- Take medicines that stop attacks when you need them
- Learn the right way to use your inhalers

Call your doctor or go to the hospital if it is hard to breathe and your medicines are not helping

Things to ask your doctor:

Which medicines are to keep attacks from happening?

Which medicines are to stop attacks when they come on?

Can you show me the right way to use my inhaler?

Can I use my inhalers more often if I need to?

What are the side effects of my inhalers and my other medicines?

Do I need a special meter to check my breathing at home? How do I use it?

How long should I wait to call the doctor or go to the hospital if I am having trouble breathing?

*HEALTH TiPS are developed by the American College of Physicians Foundation and PIER

Patient Information

CME Questions

MKSAP
MEDICAL KNOWLEDGE Self-Assessment Program

1. A 46-year-old woman with persistent asthma is evaluated in the clinic for a scheduled follow-up visit. Since her most recent visit 6 months ago, her disease has been stable on a regimen of high-dose inhaled corticosteroids plus a long-acting β-agonist and as-needed albuterol, which she uses approximately once every 1 to 2 weeks. The patient is pleased with the current therapy, and the as-needed albuterol is continued.

   Which of the following would be the best approach to this patient's therapy?

   A. Continue inhaled corticosteroids and the long-acting β-agonist at current doses
   B. Discontinue inhaled corticosteroids and the long-acting β-agonist
   C. Continue the long-acting β-agonist and reduce the dose of inhaled corticosteroids
   D. Discontinue the long-acting β-agonist and reduce the dose of inhaled corticosteroids

2. A 75-year-old woman with a long-standing history of asthma is evaluated for increased nocturnal asthma symptoms and frequent need to use an albuterol inhaler. Her treatment regimen now consists of daily moderate-dose inhaled corticosteroids.

   On physical examination she has occasional wheezing; the examination is otherwise unremarkable. Office spirometry shows an FEV_1 of 2.2 L (75% of predicted).

   Which of the following is the most appropriate adjustment to this patient's therapy?

   A. Double the inhaled corticosteroid dose
   B. Add theophylline
   C. Add a leukotriene-receptor antagonist
   D. Add a long-acting β-agonist
   E. Add anti-IgE antibody

3. A 38-year-old woman is evaluated for worsening control of mild persistent asthma. Her disease had been under good control on therapy with moderate-dose inhaled corticosteroids plus as-needed albuterol until 6 weeks ago when she had an acute respiratory tract infection. Since then she has had significant worsening of her symptoms, with nightly cough and wheezing. She uses an albuterol rescue inhaler 6 to 8 times per day.

   Which of the following is the most appropriate therapy for this patient?

   A. A 7-day course of a fluoroquinolone antibiotic
   B. Nebulized albuterol–ipratropium bromide at home
   C. A short course of oral corticosteroid therapy
   D. A leukotriene-receptor antagonist

4. A 28-year-old man is evaluated for a 6-month history of episodic dyspnea, cough, and wheezing. He had asthma as a child but has been asymptomatic since his early teens. The recent symptoms, which began after an upper respiratory tract infection, are often triggered by exercise or exposure to cold air and awaken him from sleep 3 or 4 times per month.

   On physical examination, vital signs are normal. There is scattered wheezing in both lung fields. Office spirometry shows an FEV_1 75% of predicted with a 15% improvement (370 mL) after inhaled albuterol. Chest radiographs are normal.

   Which of the following is the most appropriate therapy for this patient?

   A. Albuterol by metered-dose inhaler as needed
   B. Long-acting β-agonist plus as-needed albuterol
   C. Long-acting β-agonist
   D. Inhaled corticosteroids plus as-needed albuterol
   E. Long-term antibiotic therapy

5. A 19-year-old woman is evaluated for possible asthma. She has known seasonal allergies that manifest as hay fever in fall and spring. Symptoms are restricted to her nose and eyes, and she has no history of wheezing or chest tightness. The patient had a methacholine test as part of a research study, which showed borderline response.

   Which of the following would be the most appropriate management for this patient?

   A. Inhaled corticosteroids and a long-acting β-agonist
   B. Seasonal nasal corticosteroids and antihistamine
   C. Albuterol inhaler as needed
   D. Repeat methacholine challenge

6. A 37-year-old man with asthma is evaluated because he continues to have frequent attacks and now believes that his short-acting β-agonist is not providing relief. Other medications he reportedly uses include a long-acting β-agonist inhaler, inhaled high-dose corticosteroids, and a short-acting β-agonist inhaler as rescue medication. He has symptoms daily and nocturnal symptoms about twice per week.

   On physical examination, he is in mild respiratory distress. Temperature is 37°C (98.6°F), blood pressure is 140/85 mm Hg, pulse rate is 90 beats/min, and respiration rate is 18 breaths/min. He has bilateral wheezing and oral thrush. Office spirometry shows FEV_1 65% of predicted, which improves with bronchodilators to 85% of predicted. He has no history of recent viral upper respiratory infections, rhinitis, or symptoms of gastroesophageal reflux disease.

   Which of the following is the best next step in this patient's management?

   A. Add a leukotriene inhibitor
   B. Observe the patient using the metered-dose inhaler
   C. Start oral prednisone therapy and have the patient return for a pill count
   D. Have the patient return with a symptom and treatment log

Questions are largely from the ACP's Medical Knowledge Self-Assessment Program (MKSAP). Go to www.annals.org/intheclinic/ to obtain up to 1.5 CME credits, to view explanations for correct answers, or to purchase the complete MKSAP program.