The Asthma Center
Education and Research Fund
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# Pediatric


## Introduction

Although asthma is a common disease, it is not always recognized that asthma has become the most common chronic disease of childhood. Symptoms of wheezing, coughing and/or shortness of breath are indeed common among infants and children. While these symptoms, when caused by asthma, usually respond well to appropriate medications, the exact diagnosis is not always obvious early in the evaluation of such patients.

Diagnostic errors occur because the differential diagnosis of wheezing and related symptoms is very large for pediatric patients. In fact, asthma-mimicking symptoms are caused by more than 50 different childhood diseases (see Table 1, Differential Diagnosis). Therefore, before settling on an asthma diagnosis, a prudent physician should define all triggers and categorize the type of asthma while ruling out other diagnostic considerations and co-morbidities.

Accurate diagnosis of these symptoms can be challenging at times, as there is no specific physiologic, biologic, or immunologic marker for asthma in children. Clinicians base their diagnosis on multiple factors, such as family/personal history, symptom patterns, risk factors, diagnostic testing, and response to therapy. Infantile asthma refers to asthma in children under 3 years of age with four or more episodes of wheezing that improve with bronchodilators or anti-inflammatory therapies. The younger the child, the greater the vulnerability for a severe asthma attack. Hospital admission rates are increasing among infants with asthma. Asthmatic children under 2 years old are four times more likely to be admitted to the hospital than teenagers with asthma.

Approximately 9 million children have been diagnosed with asthma in the United States, most with symptoms occuring before 5 years of age. The prevalence of asthma has increased in western countries over the last 20 years, which may be due to an increase in the prevalence of allergy. Diagnoses of pediatric asthma doubled in the 1990s, as compared to the number diagnosed in the 1980s. Forty percent of children develop asthma when both parents have a history of the disease. Asthma morbidity is significant with regard to school absenteeism, with an estimated 12.8 million school days lost during the previous year.

In most children's hospitals in the United States, asthma is the most common diagnosis at admission. The current asthma prevalence is estimated to be 6.7% in adults and 8.5% in children. While asthma can result in a fatal outcome, with proper and timely treatment and education, asthma-related fatalities in children are mostly preventable.

## Distinctive features

Asthma is more likely to be episodic in children and persistent in adults. Children tend to be more allergic than adults, with elevated IgE levels and positive skin tests. Allergic childhood asthma is often associated with diseases such as food allergy and/or atopic dermatitis. Children may develop hyperinflation more rapidly than adults. The $FEV_1$ values (measurements of lung function) at all severity levels can return to normal levels when they are clinically stable, and these asthmatics usually respond well to bronchodilators. Early in childhood, small airways are frequently affected with an increase in peripheral airway resistance without significant large airway involvement. Commonly, there is a shift between early infancy or childhood and later childhood or adolescence marked by an increased degree of large airway involvement.

## Common patterns

Wheezing in infants and young children can be divided into three specific groupings:

■ ***Early transient wheezers.*** These children's symptoms are primarily due to viral infections. Members of this group usually do not wheeze between infectious episodes. Symptoms often resolve early in childhood.

■ ***Late-onset, non-atopic wheezers.*** These non-allergic children will wheeze as a result of viral infections, exercise and cold air exposure. Symptoms peak between 3 and 6 years of age with a gradual decline over the ensuing years. Symptoms may resolve in the second decade of life, although a minority will have a recurrence as adults.

■ ***Persistent atopic wheezing/asthma.*** This third pattern of childhood asthma combines a history of wheezing with evidence of IgE-mediated (allergic) disease. These atopic (allergic) patients are most likely to have persistent wheezing. This group gradually increases in number until it becomes the most common cause of wheezing by 6 years of age.

## Risk Factors

The Asthma Predictive Index (or risk factors for asthma) includes: a history of: atopic dermatitis (eczema), allergic rhinitis, parental asthma, wheezing occurring without a viral upper respiratory infection, and blood eosinophilia greater than 4%. The incidence of asthma can rise to 40% in infants admitted to a hospital with RSV respiratory infections, such as bronchiolitis. Children with evidence of IgE-mediated disease will more likely have persistent wheezing than those without allergy.

Correctly identifying asthma and possible triggers early in the disease process is essential in determining the best therapy that promotes long-term remission. Effectively-controlled asthma depends on identifying triggers early, instituting environmental controls, or decreasing allergen hypersensitivity with immunotherapy (allergy shots) when appropriate. Further, failure to immunize against influenza puts the child at a greater risk for a severe asthma flare, should they contract this common virus. Severe, repeated asthma attacks are more likely to cause chronic asthma and have been associated with permanently altered airways—resulting in chronic airway obstruction.

### Triggers of kids' asthma

- Viral infections
- Environmental allergens
- Irritants (e.g., smoke exposure, chemicals, vapors, dust)
- Exercise
- Emotions
- Home environment (e.g., carpets, pets, mold)
- Stress
- Drugs (e.g., aspirin, beta blockers)
- Foods
- Changes in weather
- Other conditions (e.g., thyroid disease, adolescent pregnancy, menses, gastroesophageal reflux disease/GERD, sinusitis, rhinitis)
- Dust mites

### 1. Infection

More than 80% of infant hospitalizations due to asthma result from viral respiratory tract infections. Respiratory syncytial virus is considered the most common viral cause of wheezing in infants. Metapneumovirus is a newly identified cause of cold weather exacerbations of asthma in children, causing prolonged hospitalizations. In addition, other investigators have also identified the rhinovirus as a frequent culprit.

### 2. GERD

Gastroesophageal reflux disease is a common cause of wheezing in infants under 1 year of age. Studies of bronchoalveolar lavage samples in infants with asthma have revealed evidence of inflammation with increased neutrophils, macrophages, IL-8, and myeloperoxidase which suggest aspiration associated with gastroesophageal reflux (GERD). It has been shown that treatment of GERD will substantially reduce asthma medication requirements in affected patients. GERD is also a common co-morbid disease in difficult-to-manage asthma and should always be ruled out in such cases.

### 3. Allergic rhinitis, sinusitis, and upper respiratory tract infections ( URTI )

Inflammatory conditions of the upper airways (e.g., allergic rhinitis, sinusitis, or chronic and persistent infections) should be treated in order to better control asthma symptoms. Inflammation of the upper airway can provoke lower airway symptoms. In other words, in asthma, what affects the upper airway also can affect the lower airway. For example, chronic sinusitis can worsen asthma in spite of appropriate asthma treatment.

### 4. Passive smoke inhalation

It is known that **passive cigarette smoke** triggers asthma and may lead to an increase in airway responsiveness in infants. Up to 13% of asthma in children under 4 years old is reportedly due to exposure to maternal smoking.

Even fetal smoke exposure is linked to childhood asthma. The childhood consequence of asthma is a risk factor for adult asthma.

## 5. Allergy

The development of allergy is also a significant trigger of asthma. Recent studies by Delacourt et al and Wilson et al have shown that wheezing children under 3 years old had positive skin testing to dust mites, cat, or cockroach in 30-45% of those tested. Outdoor allergens have also been implicated, such as grass or other pollen with positive skin testing in young children and infants. The earlier the sensitization, the higher the risk for subsequent asthma in adolescence. Worst of all is the persistence of indoor allergen exposure including dust mites, cockroach, cat and dog dander, and less often, mold. Chronic exposure to these allergens in a sensitive asthmatic makes it very difficult to bring the child's symptoms under good control. This may lead to steroid dependence because of frequent flares of symptoms leading to many emergency visits and hospitalizations.

## 6. Outdoor and Indoor Air Pollution

Outdoor air pollution exacerbates asthma, increasing emergency room visits and hospitalizations among children with asthma.

Prevalence of asthma symptoms is highest in children whose households have open wood-burning stoves, which result in increased airborne particulate matter. Cigarette smoking also remains one of the most prevalent environmental factors that exacerbate pediatric asthma.

## Signs and symptoms of asthma

- Dry, hacking cough
- Wheezing
- Dyspnea
- Chest tightness or discomfort
- Nocturnal chest symptoms
- Exercise intolerance or poor sports performance
- Persistent cough or chest symptoms following a URTI
- Cold air-induced dyspnea, coughing or wheezing
- Coughing or dyspnea due to crying, yelling or singing

## Diagnosis and evaluation

Early recognition of various risk factors in pediatric asthma (including information derived from the family history), is crucial. The importance of a comprehensive environmental history cannot be overstated, as it indicates which environmental changes will improve symptoms and alter the course and severity of the child's asthma (to learn more about practical environmental changes, visit TheAsthmaCenter.org). For example, consider the child's primary environment (their home(s), relatives' homes, school, day care, sports, etc.) to which the child is exposed. A history of wheezing with exposure to pets, foods, or indoor or outdoor allergens is an indication for allergy testing.

The frequency of symptoms, missed school days, hospitalizations and emergency room visits due to asthma indicate the severity of the problem. Response to bronchodilators or steroids may provide clues to support a diagnosis of asthma. Coughing and wheezing associated with triggers other than viral infections strongly suggest the presence of asthma.

In general, coughing and wheezing symptoms without viral infections warrant allergy testing. Early allergy testing is helpful, with or without a family history suggestive of allergy. If allergy is present and immunotherapy is appropriate, the need for asthma medication can be greatly reduced. However, all allergy testing is not equal. Allergy skin tests are more sensitive than RAST/Immunocap™ and other in-vitro testing, but require greater skill in application and interpretation. Allergy testing is only part of the allergy evaluation; the results can be misleading without a correlating comprehensive allergy history.

The differential diagnosis (see Table 1) of asthma in infants and young children is indeed large, and it is necessary to exclude other causes of wheezing since congenital defects can mimic asthma in this age group.

The birth history may indicate other causes of asthma-like symptoms. For example, history of prematurity and respiratory distress with the need for intubation or artificial ventilation, feeding difficulties, recurrent vomiting, frequent formula changes, failure to thrive, recurrent pneumonia, history of heart disease, and poor response to asthma medications may lead to a non-asthma diagnosis as the cause of wheezing.

Physical examination of the wheezing child should differentiate between inspiratory and expiratory wheezing. For example, inspiratory wheezing might indicate extrathoracic obstruction, such as croup or obstruction of the upper airway. Expiratory wheezing is typical of other causes of obstruction of the bronchi or bronchioles, in addition to asthma. Expiratory wheezing associated with asthma is usually heard throughout the entire expiratory cycle or at least lasting to the end of expiration. In contrast, expiratory wheezing not carried through the end of expiration, is usually not a result of asthma. Rales and/or crepitation are not normally associated with asthma.

**Physical examination during an acute episode of asthma will reveal the severity of the asthma attack.**

■ ***Mild episode:*** The respiratory rate is increased. Accessory muscles of respiration are not used. The heart rate is less than 100 beats per minute. Pulsus paradoxus is not present. Auscultation of the chest reveals some wheezing, which is often end expiratory. Oxyhemoglobin saturation with room air is greater than 95%.

■ ***Moderately severe episode:*** The respiratory rate is increased. Typically, accessory muscles of respiration are used, and suprasternal retractions are

present. The heart rate is 100-120 beats per minute. Loud expiratory wheezing can be heard. Pulsus paradoxus may be present (10-20 mm Hg). Oxyhemoglobin saturation with room air is reduced to 91-95%.

■ ***Severe episode:*** The respiratory rate is often greater than 30 breaths per minute. Accessory muscles of respiration result in maximal retractions. The heart rate is more than 120 beats per minute. Loud biphasic (expiratory and inspiratory) wheezing can be heard. Pulsus paradoxus is often present (20-40 mm Hg). Oxyhemoglobin saturation with room air is less than 91%.

Status asthmaticus with imminent respiratory arrest: Paradoxical thoracoabdominal movement occurs. Wheezing may be absent (associated with most severe airway obstruction). Severe hypoxemia may result in bradycardia. Pulsus paradoxus noted earlier may be absent; this finding suggests respiratory muscle fatigue.

## When should a child with acute asthma go to the ER?

- Increasing shortness of breath with inadequate response to medication
- Frequent use of beta agonist inhaler (rescue inhaler) > 5x/day with inadequate relief
- Use of accessory muscles
- Chest pain
- Presence of cyanosis
- Dyspnea interfering with feeding or speaking
- 2nd acute asthma attack following release from ER
- Persistent vomiting associated with severe cough

## Co Morbidities:

1. GERD
2. Chronic sinusitis
3. Chronic allergy

All infants and children with asthma should have GERD considered in their differential diagnosis. If their history is suggestive of GERD, swallowing disorders, aspiration, or congenital defects (e.g. tracheal-esophageal fistula) they should undergo upper gastrointestinal studies including a barium swallow. If further workup is required, 24-hour esophageal pH monitoring and bronchoscopy may be necessary. Patients with uncontrolled asthma and a history of chronic nasal congestion or sinusitis should undergo allergy skin testing, rhinoscopy and/or CT scan.

## Differential Diagnosis

Evaluation of a child or infant with asthma-like symptoms needs to objectively define the type and severity of the asthma while also considering the broad differential diagnosis that exists in the pediatric patient.

Pulmonary function testing, peak flow monitoring and methacholine challenge make it possible to objectively define asthma in young children. However, these tests are more practical in children over the age of 5 or 6 years, who are adequately coordinated.

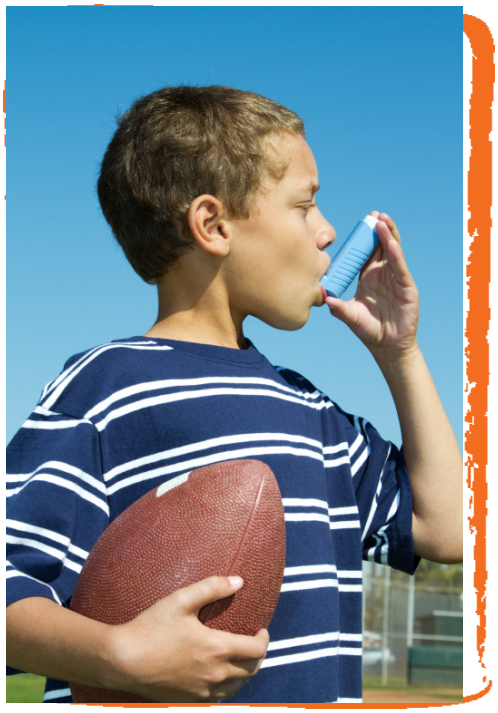
A chest x-ray should always be performed the first time an infant wheezes to rule out pneumonia as well as congenital anomalies.

A sweat test is recommended for infants and young children with asthma symptoms to rule out cystic fibrosis, which can easily mimic this disease.

If the child has a history of recurrent, severe or unusual infections, an immunodeficiency workup is necessary.

Selective allergy skin testing for aeroallergens and food allergens can be helpful in the early diagnosis and treatment of allergic asthma since antigen-specific IgE triggers can begin between 1 and 3 years of age. Although allergen induced asthma is uncommon during the first year, its prevalence increases in childhood and adolescence.

**For differential diagnosis, see Table 1.**



## Treatment

### 1. Education

Patients/caretakers must learn how medications work, their correct administration, and the proper order of use. Each patient must have an individualized emergency action plan with all necessary medications immediately available. Further, the patient or caretaker needs the knowledge and tools to assess asthma control, monitor for medication side effects, and the ability to recognize a developing asthma emergency. Education comes in many forms, however, the best way to ensure proper medication use and optimum asthma control is for the patient to be audited and educated by asthma specialists on a regular basis.

Asthma treatment in older children follows the same guidelines used when treating infants and young children, with more choices of medication—identification and elimination of triggers; regular use of anti-inflammatory maintenance medications; and as-needed use of bronchodilators for symptom relief.

The recent 2007 guidelines by the National Heart, Lung and Blood Institute (NHLBI) emphasize the assessment of both impairment and risk as determined by functional or frequency criteria.

Infants with severe asthma exacerbations and no apparent symptoms between episodes are the most difficult group in which to

determine the need for maintenance medications. The NHLBI guidelines stress that children with 4 or more episodes per year which last longer than a day and affect sleep require long-term controller therapy. Other groups of infants who require long-term therapy include those who need 2 oral corticosteroid bursts in 6 months or children that require β-agonist treatment for more than 2 days per week for more than 4 weeks.

Compliance with daily treatment for chronic asthma may be difficult due to the poor cooperation in children, as well as the reluctance of some parents to have their children on medications when they appear asymptomatic. Fortunately, the newer medications for asthma in children promise better control of wheezing with improved safety and convenience.

## 2. Allergen avoidance

Dust mite avoidance has been noted to have a modest treatment effect in infants. However, mattress encasing has helped significantly lower the necessity for steroid medications in older children. Read more about environment controls for those suffering from allergic asthma and respiratory allergy at ***TheAsthmaCenter.org.***

## 3. Medications

■ **β-2 agonists** are among the most frequently used bronchodilators. They are easy to administer via nebulizer or MDI with or without a spacer. β-2 agonists are appropriate for infants and young children. Infants and all children who have a history of acute flares of asthma should have a nebulizer available to them in order to avoid ER visits and hospitalization. Side effects include: irritability, sleep disturbances and behavioral changes. These symptoms are dose-dependent and reversible. Moreover, oral forms are more likely to cause these side effects in susceptible individuals. Continuous nebulization has been effective in severe, acute asthma when intermittent use is ineffective. Long-acting β-agonists are approved for children over 4 years of age for persistent asthma, but they must always be used along with inhaled steroids.

■ **Anticholinergic agents** have been useful as additional medications in severe infant or childhood asthma exacerbations. Ipatropium bromide

## Table 1: Differential Diagnosis

| | |
|---|---|
| **Congenital disorders** | Cystic fibrosis<br>Tracheoesophageal fistula<br>Primary ciliary dyskinesia<br>Immunodeficiency<br>Diaphragmatic hernia<br>Chronic lung disease of prematurity<br>α-1 antitrypsin deficiency<br>Pulmonary lymphangiectasia |
| **Congenital heart disease** | (many types, including defects of the heart, lungs, blood vessels, trachea, esophagus and diaphragm) |
| **Upper airway disorders** | Foreign body<br>Laryngotracheomalacia<br>Vocal cord dysfunction/paralysis<br>Laryngeal web, papillomatosis, cleft palate<br>Subglottic or tracheal stenosis<br>Hemangioma<br>Laryngeal paralysis<br>Sinus disease |
| **Lower airway disorders** | Bronchial stenosis<br>Inhaled foreign object<br>Bronchial casts, mucous plug<br>Asthma<br>Bronchomalacia<br>Lobar emphysema |
| **Infectious/post-infectious** | Epiglottitis<br>Croup<br>Tracheitis<br>Bronchiolitis<br>Diptheria<br>Chlamydia<br>*Pneumocytisis carnii*<br>Histoplasmosis<br>Bronchiectasis<br>Pertussis<br>Retropharyngeal abscess<br>Bronchiolitis obliterans |
| **Compression Syndromes** | Tuberculosis<br>Lymphadenopathy<br>Vascular ring<br>Pulmonary sling<br>Mediastinal masses<br>Congenital goiter<br>Thyroglossal duct cyst<br>Teratoma<br>Aspiration syndromes (e.g., neurogenic) |
| **Other** | Munchausen syndrome by proxy<br>Other psychopathology<br>Gastroesophageal reflux<br>Immunodeficiency |

## Table 2: Medications for Pediatric Asthma

| MEDICATION | DOSAGE |
|---|---|
| **Short-course Systemic Steroids** | |
| Prednisolone (5 mg/5 mL or 15 mg/5 mL) | 1 mg/kg/day to 2 mg/kg/day orally; maximum 60 mg/day |
| **Rescue Medications** | |
| Albuterol ampules* (.063 mg/3mL; 1.25 mg/3mL; 2.5 mg/3mL) | 0.63 mg/3ml to 2.5 mg/3mL saline every 4 to 6 hours as needed (may be dosed 2.5 mg every 20 minutes x3 doses OR 0.15 mg/kg to 0.3 mg/kg up to 10 mg every 1 to 4 hours as needed OR up to 0.5 mg/kg/hr continuous nebulization for acute exacerbations) |
| Levalbuterol (R-albuterol)* (.63 mg/3 mL; 1.25 mg/3mL) (.31mg/3 mL) | 0.63 mg/3ml to 1.25 mg/3mL saline every 4 to 6 hours as needed (may be dosed 1.25 mg every 20 minutes for 3 doses then 0.075 mg/kg to 0.15 mg/kg up to 5 mg every 1 to 4 hours as needed) |
| Ipratroprium (0.25 mg/mL saline*) (severe exacerbation only, is not to be used as first-line therapy) | 0.25 mg to 0.5 mg every 20 minutes x 3 then as needed (may mix with albuterol in nebulizer) |
| Ipratroprium with albuterol nebulizer solution: (0.5 mg ipratroprium bromide and 2.5 mg albuterol) | 1.5 mL every 20 minutes x 3 doses then as needed for up to 3 hours |
| **Maintenance Medications** | |
| Cromolyn sodium | 1 ampule 3 to 4 times per day |
| Montelukast | 4 mg orally daily (age 2-5); 5 mg orally daily (age 6-14) |
| Budesonide ampules* | 0.25 mg, 0.5 mg, 1 ampule 1-2x per day |
| Inhaled corticosteroids via metered-dose inhaler with or without the use of a spacer | Beclomethasone, budesonide, budesonide/formoterol, ciclesonide, fluticasone, fluticasone/salmeterol, mometasone (dose varies per medication) |

is a quaternary isopropyl product derived from atropine that is available as a nebulizer solution (0.25mg/ml of saline) or as a metered dose inhaler. In a current NHLBI statement, there is a recommendation that ipatropium is appropriate to use during severe exacerbations in infants as an additional treatment.

■ **Cromolyn sodium** has been available since the 1970s as an anti-inflammatory medication that inhibits degranulation of mast cells and inhibits early and late-phase asthmatic reactions to allergens. Due to its significant safety profile and lack of toxicity, it is used in young children for chronic treatment. However, it is reportedly less effective than low-dose inhaled steroids for asthma control. In addition, it is not recommended as a first-line treatment for infants and young children with chronic asthma. Since the metered dose inhaler is no longer available, nebulized cromolyn sodium is currently used in children over 1 year of age. Cromolyn is currently used by most clinicians to: 1) prevent wheezing in infants and young children as a maintenance medication; 2) to prevent allergen-induced asthma; and 3) when parents are very reluctant to treat with corticosteroids. It prevents asthma symptoms when administered prior to allergen exposure, as it blocks mast cell degranulation which triggers asthma in allergic children.

■ **Leukotriene antagonists** such as montelukast block the inflammatory effects of leukotrienes, which are chemical mediators of bronchospasm, inflammation, eosinophilia, stimulation of mucus secretion, and increased vascular permeability. This drug is approved for children 12 months and older with a dosage of 4 mg in granules for children aged 12-24 months; 4 mg for 2-5 years; 5mg for 6-14 years and 10 mg for above 15 years. Studies have shown that young children and infants improved symptom scores and nitric oxide production, although inhaled steroids were more effective.

The NHLBI guidelines list inhaled corticosteroids as the preferred first-line treatment, but montelukast is mentioned as an alternative or add-on therapy for mild-persistent to more severe asthma. Many parents prefer the use of a tablet or granule preparation as a long term controller medication in place of a corticosteroid. However, many asthmatics will not respond adequately to leukotriene antagonists, while almost all will benefit from an inhaled corticosteroid with rare significant side effects. In some patients, there may be a synergy when inhaled corticosteroids are administered along with a leukotriene antatagonist. Steroid phobia remains an important issue that needs to be addressed with some parents.

■ **Theophylline** has been used for decades, but is now in limited use due to concerns about side effects including nausea, insomnia, agitation, cardiac arrhythmias and seizures. Serum monitoring is essential in order to achieve therapeutic levels between 5-15 mg/dl. Metabolism changes must be recognized with age, diet, fever, viral infections and drug interactions in order to avoid side effects. The NHLBI guidelines continue to list Theophylline as an alternative or added therapy for children under 4 years of age due to its proven efficacy. Theophylline's narrow therapeutic window along with its

potential for serious toxic side effects and need for frequent monitoring make it an uncommon choice for the treatment of asthma because of the superiority of currently available alternatives.

■ **Corticosteroids** remain one of the most potent treatments due to their anti-inflammatory effects. These medications reduce mucus production, decrease mucosal edema, decrease inflammatory mediators and increase β-adrenergic responsiveness. Corticosteroids improve lung function, reduce airway hyperreactivity, and reduce the late-phase asthmatic response. As a maintenance therapy, inhaled steroids provide the desired anti-inflammatory treatment without significant side effects, particularly compared to oral steroid use or frequent bronchodilator treatments.

Numerous studies have shown that Budesonide (Pulmicort) and Fluticasone HFA MDI (Flovent HFA MDI) via spacer and face mask have improved pulmonary function, symptom scores and quality of life. The NHLBI guidelines indicate that inhaled steroids are the initial drug of choice in asthmatic children younger than 4 years of age. Although some studies have shown a short-term linear growth decrease in children on inhaled steroids (Budesonide and Fluticasone), catch-up growth occurs after the first year or during puberty. Current studies have not shown clinically significant adrenal suppression in infants or small children. A newer inhaled steroid, ciclesonide (Alvesco HFA) is being studied in young children due to its lower bioavailability and decreased potential for side effects. This newer generation inhaled steroid virtually eliminates systemic effects which could end concern over growth in children. The choice of inhaled steroid depends on potency, systemic absorption, taste, delivery system, and cost. Therapy must be individualized for each patient and for each pattern of disease activity.

## 4. Allergen Immunotherapy

Despite the use of inhaled steroids, asthma management in some children remains a problem. The significant role of aeroallergens in pediatric asthma suggests that allergen immunotherapy might provide a more permanent disease-modifying outcome after medical treatment is discontinued. Further, immunotherapy can decrease bronchial sensitivity and result in a lower need for medications. In older children, a 3-year course of subcutaneous immunotherapy with standardized allergen extracts has demonstrated long-term clinical effects. **In addition, subcutaneous immunotherapy has shown its potential to prevent development of asthma in children with allergic rhinoconjunctivitis.** This clinical effect was noted up to 7 years after treatment. However, subcutaneous immunotherapy in very young children is problematic due to the child's inability to verbalize or cooperate. Sublingual immunotherapy might be better tolerated in young children, however its efficacy is not yet fully demonstrated and it is not an approved therapy by the FDA as safe and effective at this time. Further studies are needed to determine the role of immunotherapy in altering the natural history of asthma in young children.

*For more treatment information, visit*
**TheAsthmaCenter.org**
*or*
**nhlbi.nih.gov/guidelines/asthma/**
*for guidelines*

## Summary of pediatric asthma management

■ ***Peak flow measurements*** allow monitoring of asthma control at home. Peak flow measurements can serve as an objective guide when determining the need for aggressive treatment or when to seek emergency care.

■ ***Regular followup visits*** are necessary for objective evaluation, education, and adjustment of medications in order to obtain optimum control of asthma.

■ ***Monitoring pulmonary functions during office visits*** ensures objective assessment of asthma control.

■ ***Monitoring medications*** includes regulating usage, monitoring ACT score, reviewing inhaler technique, looking for side effects, and reviewing emergency readiness.

■ ***Emergency backup meds: Nebulized Beta-2 agonists, oral corticosteroids***

■ ***Dealing with emotions*** is important for children who may be traumatized or fearful due to incidents related to their asthma. Education and confidence-building helps address these issues.

■ ***Dealing with triggers*** includes identifying and countering each trigger (e.g., allergens, exercise, cold weather, etc.) or co-morbidity, thus avoiding the need for increasing asthma medications.

■ ***Recognition of high-risk patients*** includes a history documenting frequency of asthma flares, ER visits or hospitalizations, intubation, use of oral corticosteroids, and history of anaphylaxis. Together, these are risk factors for potentially fatal asthma and should alert the physician to closely follow and educate these patients.

## Prognosis

In infants with wheezing, there is a 15% incidence of persistent symptoms after the age of 3. Risk factors that predict persistent symptoms beyond infancy include males, presence of atopy, passive smoke exposure, and a parental history of asthma.

## Conclusion

Although asthma is the most frequent chronic disease in childhood, its diagnosis and optimum treatment remain a challenge to the clinician. In many young children, early treatment of small airway disease before asthma becomes difficult to control, may be increasingly important. The NHLBI guidelines stress that some patients can still be at risk for frequent or severe exacerbations even if they have few daily symptoms. The clinician's goal is to increase the quality of life of each asthma patient while decreasing morbidity and mortality. ■

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