The Diagnosis of Wheezing in Children

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Wheezing in children is a common problem encountered by family physicians. Approximately 25 to 30 percent of infants will have at least one wheezing episode, and nearly one half of children have a history of wheezing by six years of age. The most common causes of wheezing in children include asthma, allergies, infections, gastroesophageal reflux disease, and obstructive sleep apnea. Less common causes include congenital abnormalities, foreign body aspiration, and cystic fibrosis. Historical data that help in the diagnosis include family history, age at onset, pattern of wheezing, seasonality, suddenness of onset, and association with feeding, cough, respiratory illnesses, and positional changes. A focused examination and targeted diagnostic testing guided by clinical suspicion also provide useful information. Children with recurrent wheezing or a single episode of unexplained wheezing that does not respond to bronchodilators should undergo chest radiography. Children whose history or physical examination findings suggest asthma should undergo diagnostic pulmonary function testing. (*Am Fam Physician*. 2008;77(8):1109-1114. Copyright © 2008 American Academy of Family Physicians.)

Wheezing in infants and children is a common problem presented to primary care offices. Approximately 25 to 30 percent of infants will have at least one episode of wheezing.[1] By three years of age, an episode of wheezing will have occurred in 40 percent of children, and by six years of age, almost one half of children will have had at least one episode of wheezing.[1] Most infants and children with recurrent wheezing have asthma, but other causes should be considered in the differential diagnosis. This article provides an approach to the assessment of all types of wheezing in children.

Etiology

Wheezing occurs during the prolonged expiratory phase by the rapid passage of air through airways that are narrowed to the point of closure. Children wheeze more often than adults because of physical differences. Infants' and young children's bronchi are small, resulting in higher peripheral airway resistance. As a result, diseases that affect the small airways have a proportionately greater impact on total airway resistance in these patients. Infants also have less elastic tissue recoil and fewer collateral airways, resulting in easier obstruction and atelectasis. The rib cage, trachea, and bronchi are also more compliant in infants and young children, and the diaphragm inserts horizontally instead of obliquely. All of these factors increase the likelihood of wheezing and respiratory distress in both of these groups.[2]

Differential Diagnosis

Table 1 lists common, uncommon, and rare causes of wheezing in infants and children.[3,4] Obtaining a detailed history is important; *Table 2* contains suggested questions that may help narrow the differential diagnosis.[3-5] The most common diagnoses in children with wheezing are asthma, allergies, gastroesophageal reflux disease (GERD), infections, and obstructive sleep apnea.[3,6]

FAMILY HISTORY

Recent infectious illness in the family (e.g., viral upper respiratory illness, pertussis,

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SORT: KEY RECOMMENDATIONS FOR PRACTICE

Clinical recommendation	*Evidence rating*	*References*
Asthma is the most likely cause of recurrent wheezing in children younger than five years.	C	1
The most common causes of wheezing in young children are asthma, allergies, gastroesophageal reflux disease, infections, and obstructive sleep apnea.	C	6, 12, 16, 24
Response to bronchodilators may help differentiate asthma from other causes of wheezing.	C	1, 7
Chest radiography should be performed in children with recurrent wheezing or a single episode of unexplained wheezing that does not respond to bronchodilators.	C	1, 7, 19

A = consistent, good-quality patient-oriented evidence; B = inconsistent or limited-quality patient-oriented evidence; C = consensus, disease-oriented evidence, usual practice, expert opinion, or case series. For information about the SORT evidence rating system, see page 1063 or http://www.aafp.org/afpsort.xml.

tuberculosis) suggests probable causes of wheezing. A family history of asthma, allergies, or eczema increases suspicion of asthma.

AGE AT ONSET

The age at onset helps to distinguish between congenital and noncongenital causes of wheezing. In infants, wheezing is more likely to be caused by a congenital abnormality than in older children.

Table 1. Causes of Wheezing in Children and Infants

Common	**Rare**
Allergies	Bronchiolitis obliterans
Asthma or reactive airway disease	Congenital vascular abnormalities
Gastroesophageal reflux disease	Congestive heart failure
Infections	Cystic fibrosis
Bronchiolitis	Immunodeficiency diseases
Bronchitis	Mediastinal masses
Pneumonia	Primary ciliary dyskinesia
Upper respiratory infection	Tracheobronchial anomalies
Obstructive sleep apnea	Tumor or malignancy
Uncommon	Vocal cord dysfunction
Bronchopulmonary dysplasia	
Foreign body aspiration	

Information from references 3 and 4.

PATTERN

The pattern of wheezing may suggest the etiology. Episodic wheezing that is seasonal or is associated with environmental exposures is likely to be caused by asthma.[4] Persistent wheezing from birth is likely the result of a congenital anatomic anomaly, and children with persistent respiratory illnesses with wheezing should be evaluated for cystic fibrosis, bronchopulmonary dysplasia, laryngomalacia, agammaglobulinemia, and primary ciliary dyskinesia.[7]

SEASONALITY

Some cases of wheezing are seasonal. Upper and lower respiratory tract infections can cause wheezing. Respiratory syncytial virus (RSV) is a significant cause of wheezing in young children. Most RSV infections in the United States occur between November and May, with peak activity in January or February.[8] RSV is the most common cause of bronchiolitis in children, with 80 percent of cases occurring in children younger than one year.[9] Other viruses known to cause wheezing in children include human metapneumovirus, which typically affects infants from December through April,[10] and human bocavirus, which is a parvovirus found in young children hospitalized for lower respiratory tract infections.[11] Although the prevalence of human bocavirus in the United

Table 2. Questions to Distinguish the Etiology of Wheezing in Children

Question	*Indications*
How old was the patient when the wheezing started?	Distinguishes congenital from noncongenital causes
Did the wheezing start suddenly?	Foreign body aspiration
Is there a pattern to the wheezing?	Episodic: asthma
	Persistent: congenital or genetic cause
Is the wheezing associated with a cough?	GERD, sleep apnea, asthma, allergies
Is the wheezing associated with feeding?	GERD
Is the wheezing associated with multiple respiratory illnesses?	Cystic fibrosis, immunodeficiency
Is the wheezing associated with a specific season?	Allergies: fall and spring
	Croup: fall to winter
	Human bocavirus*
	Human metapneumovirus: December through April
	RSV: fall to spring
Does the wheezing get better or worse when the patient changes position?	Tracheomalacia, anomalies of the great vessels
Is there a family history of wheezing?	Infections, allergic triad

GERD = gastroesophageal reflux disease; RSV = respiratory syncytial virus.

**—Although the prevalence of human bocavirus in the United States has not been well studied, it is most common in the first, second, and fourth quarters of the year in Canada.[5]*

Information from references 3 through 5.

States has not been well studied, it is most common in the first, second, and fourth quarters of the year in Canada.[5] Wheezing associated with croup is more common in the fall and winter. Wheezing associated with outdoor allergens is more common in the spring and fall; indoor allergens to dust mites and house pets can cause symptoms year-round. Wheezing from asthma can be triggered by changes in weather.[4]

WHEEZING AFTER FEEDING

Although tracheoesophageal fistulas and laryngeal clefts are rare causes of vomiting and wheezing after feeding, these symptoms are usually caused by GERD.[7,12] Infants with GERD typically have poor weight gain and may have been offered numerous formulas for "milk intolerance." The long-assumed association between GERD and airway hyperresponsiveness has recently been called into question by a small randomized controlled trial that found that giving a proton pump inhibitor to asthmatic children with GERD did not reduce asthma symptoms.[13]

SUDDEN ONSET

Foreign body aspiration can occur anytime, but it is most common between eight months and four years of age.[14] High airway obstruction causes coughing, gagging, choking, and wheezing. However, symptoms are not as dramatic and are often difficult to diagnose when the object is aspirated into the subglottic area. Laryngotracheal foreign bodies are usually discovered within 24 hours, and 90 percent of children with laryngotracheal foreign bodies are diagnosed within one week.[14] Children may have recurrent symptoms or nonresolution of pneumonia as a result of obstructive atelectasis.

COUGH

A cough after eating in a wheezing child suggests GERD.[12] A dry, unproductive cough that worsens at night can be a result

of GERD, allergies, or asthma. Obstructive sleep apnea should be considered in children whose coughing or wheezing awakens them at night and is associated with snoring. Sleep apnea in infants is usually a result of craniofacial anomalies, but the main cause in older children is adenotonsillar hypertrophy.[6]

MULTIPLE RESPIRATORY ILLNESSES

Multiple respiratory illnesses without obvious cause in the first year of life suggest cystic fibrosis, immunodeficiency syndromes, or primary ciliary dyskinesia. Steatorrhea and failure to thrive further suggest cystic fibrosis. With the widespread use of neonatal screening, cystic fibrosis is often discovered at birth. Continuous rhinitis from birth is consistent with primary ciliary dyskinesia.[7] Another uncommon cause of wheezing is congenital laryngomalacia, which can present as multiple respiratory infections and can present later in childhood.[15]

A cough after eating in a wheezing child suggests gastroesophageal reflux disease.

POSITIONAL CHANGES

Tracheomalacia and anomalies of the great vessels should be considered when wheezing occurs with positional changes in infants.

Physical Examination

Children who appear chronically ill should be tested for metabolic disorders, immunodeficiency, and cystic fibrosis. In infants, wheezing that is audible without a stethoscope and that is not associated with respiratory distress is usually a sign of a congenital airway lesion.[16]

Children can be examined in the parent's arms, if necessary. Retractions, nasal flaring, and grunting can signal respiratory distress. Auscultation can identify the presence and location of wheezing, stridor, and crackles; however, these physical findings may be absent in children who are unable to take a deep breath. Skin; cardiac; and ear, nose, and throat examination may also be helpful. Signs and symptoms such as allergic shiners, atopic dermatitis, lymphadenopathy, a heart murmur, and rhinorrhea can suggest a diagnosis. Clubbing and nail color changes suggest chronic respiratory disease other than asthma. *Table 3* lists history and physical examination findings that suggest specific causes of wheezing.[3,4,16,17]

Diagnostic Testing

Diagnostic testing should be modified according to the child's age and the suspected etiology. Bandage probes attached to a pulse oximeter are useful for infants and younger children. If a specific bacterial or viral illness is suspected, appropriate diagnostic tests should be performed (e.g., respiratory syncytial virus swabs, sputum and blood cultures, tuberculosis testing). However, testing should be ordered only if the results would alter treatment. A sweat chloride test is helpful in the diagnosis of cystic fibrosis. If immunodeficiency is suspected, serum immunoglobulin levels should be measured and a complete blood count ordered. Testing for GERD can be done with pH monitoring, barium swallow, or endoscopy.[12,18] Allergy testing can be performed in children older than two years.[18]

CHEST IMAGING

Chest radiography is indicated in children who present with unexplained wheezing that is unresponsive to bronchodilators or with recurrent wheezing.[3,7,19] Plain-film radiography can identify congenital anomalies of the lung, parenchymal lung disease, and some foreign bodies and cardiac abnormalities.[3] If radiography is normal and the child continues to wheeze, bronchoscopy should be the next step to rule out a congenital anomaly.[15]

Chest radiographs obtained during inspiration and expiration should be compared to detect radiolucent foreign bodies and changes associated with a blockage of a mainstem bronchus (i.e., localized hyperinflation, mediastinal shift, postobstructive changes, atelectasis).[20,21] Foreign bodies are revealed in 23 to 67 percent of patients.[22,23] A barium swallow may detect vascular rings and esophageal compression.[24] Computed tomography can identify lung nodules and bronchiectasis, but these are uncommon causes of wheezing in children.[18] If further imaging is warranted, magnetic resonance

Table 3. Differential Diagnosis of Wheezing According to Characteristic Signs and Symptoms

Signs and symptoms	*Presumptive diagnosis*	*Further evaluation*
Associated with feeding, cough, and vomiting	Gastroesophageal reflux disease	24-hour pH monitoring Barium swallow
Associated with positional changes	Tracheomalacia; anomalies of the great vessels	Angiography Bronchoscopy Chest radiography CT or MRI Echocardiography
Auscultatory crackles, fever	Pneumonia	Chest radiography
Episodic pattern, cough; patient responds to bronchodilators	Asthma	Allergy testing Pulmonary function testing Trial of albuterol (Proventil)
Exacerbated by neck flexion; relieved by neck hyperextension	Vascular ring	Angiography Barium swallow Bronchoscopy Chest radiography CT or MRI
Heart murmurs or cardiomegaly, cyanosis without respiratory distress	Cardiac disease	Angiography Chest radiography Echocardiography
History of multiple respiratory illnesses; failure to thrive	Cystic fibrosis or immunodeficiency	Ciliary function testing Immunoglobulin levels Sweat chloride testing
Seasonal pattern, nasal flaring, intercostal retractions	Bronchiolitis (RSV), croup, allergies	Chest radiography
Stridor with drooling	Epiglottitis	Neck radiography
Sudden onset of wheezing and choking	Foreign body aspiration	Bronchoscopy

CT = computed tomography; MRI = magnetic resonance imaging; RSV = respiratory syncytial virus.

Information from references 3, 4, 16, and 17.

imaging can identify complex fluid collections and differentiate between soft tissue pathology, such as tumors, fibrosis, or postobstructive pneumonitis.[25]

Immediate bronchoscopy should be performed if foreign body aspiration is suspected. Bronchoscopy will reveal compression from endobronchial lesions, mucosal inflammation, or dynamic narrowing. Bronchoalveolar lavage can help diagnose infection, hemosiderosis, or aspiration.[24,26]

TESTING FOR ASTHMA

If the history or physical examination suggests asthma, clinical guidelines recommend pulmonary function testing.[6] Spirometry is most accurate in children older than eight years and can detect reversible obstruction and hyperresponsiveness in the airways.[27-29] Current guidelines from the National Asthma Education and Prevention Program recommend attempting spirometry in children older than five years.[4] Spirometry is being used in children as young as three years, but standard reference values for younger children have not been established.[27] An abnormal bronchial challenge test with methacholine (Provocholine), cold air, or exercise provides more evidence for specific asthma diagnoses, but these tests are usually not necessary unless the diagnosis is uncertain.

In-office peak flow testing can be helpful to determine treatment effectiveness in children four years and older. Although it is effort-dependent, it can be used to compare pre- and postbronchodilator forced expiratory volume and to assess the patient's response to treatment over time.[17]

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