Defining Asthma in the Preschool-Aged Child

Robert C. Strunk, MD

ABSTRACT. A physician faces many challenges in making a definitive diagnosis of asthma in young children. Although there are clinical and historical features consistent with asthma, identical features are present in many other diseases. Furthermore, there is no specific test for asthma. Other diseases must always be ruled out before a definitive diagnosis of asthma is made. Determining whether cough or wheeze is the primary symptom is important because asthma is primarily a wheezing disease. Sweat chloride testing, chest radiography, and allergy skin testing should be performed in children with persistent wheezing to rule out other causes and help support a diagnosis of asthma. Allergy skin testing provides particularly useful information for making a diagnosis of asthma in the preschool-aged child. A chart review of patients presenting consecutively to the Division of Allergy and Pulmonary Medicine provides insight and information on an approach to make an asthma diagnosis for this population. Pediatrics 2002;109:357–361; reactive airway disease, wheezing, chest radiography, sweat chloride testing, allergy skin testing.

ABBREVIATION. GI, gastrointestinal.

Making a definitive diagnosis in children younger than 3 years of age who experience recurrent respiratory symptoms may be one of the last true art forms in medicine. Diagnosing asthma in young children follows a general approach, and requires broad thinking, the ability to work with the patient’s family and gain their trust and respect, and the persistence and precision in ruling out other possible diagnoses. A narrow focus can result in missing an important cause of respiratory symptoms, which can lead to unnecessary treatment or undertreatment and consequential morbidity.

The working definition of asthma set forth in the Guidelines for the Diagnosis and Management of Asthma indicates that asthma is a “chronic inflammatory disorder of the airways” characterized by “recurrent episodes of wheezing, breathlessness, chest tightness, and coughing.” Furthermore, “... these episodes are usually associated with widespread, but variable airflow obstruction.” Although this definition is technically correct, it is not helpful in making a diagnosis in young children. Chronic inflammation can be present in other lung diseases and can cause the same pattern of recurrent chest symptoms (Table 1). Because there is no specific test for asthma, other diseases must be ruled out before a diagnosis of asthma can be made.

When diagnosing the cause of recurrent respiratory symptoms in a young child, it is important to keep in mind the appropriate terminology that differentiates common possible causes of recurrent chest symptoms and the specific characteristics associated with each disease (Table 2). The approach to making a diagnosis of the cause of recurrent chest symptoms starts with a clinical definition of the problem, providing a broad general context within which to start thinking about different diagnostic possibilities. The initial part of this process is to determine whether the child has reactive airway disease. This phrase simply describes a syndrome of respiratory symptoms that respond to medication (usually bronchodilator, but could also include steroids). When this term is used, it provides a framework in which to think about specific causes of the reactivity. Making the assumption that the syndrome of reactive airway disease is synonymous with asthma narrows the approach to other diagnostic possibilities too rapidly and opens the clinician to missing an important differential diagnosis. The term asthma describes a disease process. An asthma diagnosis means that no other reactive airway disease is present.

Relatively few new tests have been developed that facilitate the diagnosis of asthma in children 3 years of age or younger. In clinical practice, 3 evaluations—chest radiography, sweat chloride testing, and allergy skin testing—generally serve as standards of cost-effective assessment for eliminating other illnesses and confirming a diagnosis in the asthmatic child. Radiographic examination of the upper gastrointestinal (GI) tract with barium is often

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necessary to determine presence of mediastinal structures impinging on the airway and abnormalities in the esophagus and stomach that could lead to reflux and eventual aspiration. In following patterns of swallowing, video fluoroscopy can assist in ruling out aspiration. Computed tomography of the chest and sinuses may provide useful information for ruling out nonasthmatic disease. Pulmonary function tests are useful in research studies, but infrequently offer practical clinical information in preschool-aged children.

A chart review of 50 children younger than 3 years of age at the time of evaluation for recurrent respiratory symptoms provided insights into the typical characteristics of asthma. The review also provided information regarding the validity of using specific tests to make a diagnosis of asthma in this patient population.

METHODS

The charts of 50 children younger than 3 years of age were reviewed. The children presented consecutively to the Division of Allergy and Pulmonary Medicine at St Louis Children’s Hospital over a 3-month period. These patients were seen by 1 of 2 pediatricians with subspecialty certification in Allergy Immunology. The children were experiencing recurrent respiratory complaints and referred by their physicians for evaluation of diagnosis and establishing treatment. The children, all of whom were full-term at birth, were either first-time patients or were returning for a follow-up evaluation but were still <3 years of age. Their charts were reviewed to determine the frequency of distinct signs and symptoms of asthma and the value of specific diagnostic measures. A diagnosis was made based on the compilation of historical, physical examination, and laboratory findings.

Patient Characteristics

The mean age of the children at presentation was 14.2 months (±7.4 months; range: 3–33 months). The mean age at onset of symptoms reported by parents during the initial visit was 6.2 months (±6.8 months; range: 0–30 months). Most parents reported wheeze as their child’s primary symptom; however, cough or cough and wheeze were also common complaints (Table 3). Other symptoms included hard breathing, increased respiratory rate, runny nose without cold, pneumonia, and retracting.

Patient History

The history routinely included questions on the influence of exercise on respiratory symptoms. Sixty percent (30 of 50 patients) had a history of symptom exacerbation with exercise. Initially, 6 of these children had a negative history, but parents later reported exercise-induced worsening of symptoms. The mean age of the 24 children with exercise-associated symptoms at the time of the initial evaluation was 15 months (±6 months), compared with 14.9 months (±7.4 months) in the 20 children with no exercise-induced symptoms. These data suggest that absence of exercise symptoms in 20 of the children was not simply a function of the children being too young to have significant exercise.

Questions concerning the children’s environment were also included in the patient history. Twenty-two of the 50 patients had a pet, most commonly a dog. Table 4 indicates that 13 mothers smoked (and had presumably smoked during pregnancy). Table 4 indicates that 19 of the children had some regular exposure to someone who smoked, although in one third of these cases, this person was someone who did not live with the child.

Thirty of the children had a history of recurrent otitis media. Parents of 21 of the children reported their child had continuous rhinitis, and 13 indicated that their child snored. Nine of the patients had eczema. The family history for asthma, either that of the mother or father, was positive for 17 of the children.

Tests and Measurements

The most frequently ordered test was a chest radiograph, which was performed in 48 of the 50 patients. Sweat chloride testing to rule out cystic fibrosis was performed in 31 children. Allergy skin tests were conducted in nearly half (24) of the patients. Thirty children underwent sinus radiography, and 13 had an upper GI series. Pulmonary function tests and bronchoscopy were performed in only 5 children each.

RESULTS

Asthma was the final diagnosis in 35 of the children with respiratory symptoms (Table 4). Based on clinical findings and a positive radiograph, a diagnosis of sinusitis was made in 5 children. Aspiration was documented in 2 children. One child had recurrent croup, but no other accompanying stigmata of asthma. For 7 children, no diagnosis had been made by the time of chart review. There seemed to be no

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TABLE 2. Working Definitions for Asthma, Sinusitis, and Aspiration

<table>
<thead>
<tr>
<th>Diagnosis</th>
<th>Presenting Symptoms</th>
<th>Response to Medications</th>
<th>Exacerbating Factors</th>
<th>Differential Diagnosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asthma</td>
<td>Generally wheeze or cough accompanied by wheezing; rarely cough by itself</td>
<td>Responsive to bronchodilators or oral steroids in short-term or inhaled antiinflammatory agents in long-term.</td>
<td>Typical history of exacerbating factors, such as upper respiratory tract infection, irritant exposure, exercise, allergen exposure.</td>
<td>All need to be considered</td>
</tr>
<tr>
<td>Sinusitis</td>
<td>Primarily cough, can wheeze as well</td>
<td>Poorly or incompletely responsive to bronchodilators or steroids. History of response to antibiotics, but rapid relapse especially when generally given in short.</td>
<td>Generally upper respiratory tract infection.</td>
<td>Asthma</td>
</tr>
<tr>
<td>Aspiration</td>
<td>Cough or wheeze</td>
<td>Response to medications similar to that for asthma.</td>
<td></td>
<td>Cystic fibrosis</td>
</tr>
</tbody>
</table>

TABLE 3. Most Commonly Occurring Signs and Symptoms at Presentation*

<table>
<thead>
<tr>
<th>Sign/Symptoms</th>
<th>Number of Patients (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wheeze</td>
<td>20 (40)</td>
</tr>
<tr>
<td>Cough and wheeze</td>
<td>12 (24)</td>
</tr>
<tr>
<td>Cough</td>
<td>11 (22)</td>
</tr>
<tr>
<td>Other</td>
<td>7 (14)</td>
</tr>
<tr>
<td>Hard breathing</td>
<td></td>
</tr>
<tr>
<td>Runny nose without cold</td>
<td></td>
</tr>
<tr>
<td>Pneumonia</td>
<td></td>
</tr>
<tr>
<td>Retracting</td>
<td></td>
</tr>
</tbody>
</table>

* Chart review of 50 consecutive patients younger than 3 years of age to the Division of Allergy and Pulmonary Medicine at St Louis Children’s Hospital over an approximate 3-month period (Tables 3–5).
relationship between the age of the patient at symptom onset and the diagnosis made (Table 4).

As indicated from the findings of the chart review, asthma is primarily a wheezing disease. Among the children with wheezing only as a symptom, all either had asthma or no definitive diagnosis made by the time of chart review (Table 4). The diagnoses were more equally distributed among the children with cough only. Similarly, children with exercise-induced worsening of symptoms were more likely to have asthma (21 of the 35 children with asthma had this symptom), although 3 of the 5 children with sinus disease and 1 of the 2 with aspiration also experienced worsening of symptoms with exercise.

A diagnosis of asthma was more frequently made in children whose mothers smoked, as well as in children with eczema (Table 4). Continuous rhinitis did not distinguish between asthmatic and nonasthmatic children. It is interesting that 11 of the 13 children who reportedly snored were given a diagnosis of asthma (the other 2 children with snoring were not given a diagnosis), which might represent the magnitude of effect that asthma has on both the upper and lower airways. Although a history of recurrent otitis media may be helpful in diagnosing upper and lower airways. Although a history of recurrent otitis media may be helpful in diagnosing upper and lower airways, several children with asthma did not have such a history. Family history adds some information but is helpful in recognizing <50% of the children with asthma.

Asthma severity was determined according to criteria from the Expert Panel Report 2, from the National Asthma Education and Prevention Program of the National Heart, Lung, and Blood Institute. Based on symptoms in the last month and/or medications used to control symptoms, 10 had intermittent asthma, 9 had mild persistent, 7 had moderate persistent, and 9 had severe persistent. Although 8 of the 9 children with severe persistent asthma experienced worsening of symptoms on exercise, a similar percentage of children with mild persistent disease (7 of 10) experienced such a response, as did 3 of the children with intermittent asthma. Thus, although exercise-induced worsening of symptoms may suggest asthma, it does not indicate severity of the disease.

Positive skin tests were very prevalent in children with a diagnosis of asthma (Table 5). Of the 16 children with asthma and skin tested, 56% had a positive test. Of the 9 children who had positive skin tests, all were given a diagnosis of asthma. Of the 7 children with asthma and having a sinus radiograph, 43% had a positive result, consistent with sinusitis worsening the clinical course of asthma.

A chest radiograph is taken to look for diseases other than asthma that can present with recurrent cough or wheeze. Children with asthma may have infiltrates during acute exacerbation, but the chronic findings are almost limited to peribronchial cuffing and mild perihilar infiltrates. Children with recurrent aspiration will often have persistent infiltrates even when the acute illness has resolved. Children with cystic fibrosis can have normal radiographs or may have severe hyperinflation only. Other diseases that can present with abnormal radiographs include, but are not limited to, cystic adenoid malformation, tuberculosis, vascular ring with a right-sided aortic arch, and mediastinal mass. These diseases have all been diagnosed in children presenting to St Louis Children’s Hospital for wheezing in the past year, but none were present in this series.

**DISCUSSION**

The term reactive airway disease includes a broad scope of diseases and conditions. Physicians face several challenges in making a diagnosis among the list of diseases that present with airway reactivity. Although wheezing is an important clinical feature of asthma, not all children who wheeze have asthma.

**TABLE 4.** Diagnosis and Related Symptoms

<table>
<thead>
<tr>
<th>Diagnosis</th>
<th>Number of Patients (%)</th>
<th>Age at Symptom Onset</th>
<th>Presenting Symptoms</th>
<th>Exercise induced</th>
<th>Environment Smoking</th>
<th>ROS</th>
<th>Family History: Male or Female</th>
<th>With Asthma</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>&lt;6 Months</td>
<td>&gt;6 Months</td>
<td>Cough</td>
<td>Cough/Wheeze</td>
<td>Wheeze</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Asthma</td>
<td>35 (70)</td>
<td>24</td>
<td>11</td>
<td>6</td>
<td>9</td>
<td>17</td>
<td>21</td>
<td>10</td>
</tr>
<tr>
<td>Sinusitis</td>
<td>5 (10)</td>
<td>2</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Aspiration</td>
<td>2 (4)</td>
<td>2</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Recurrent cough</td>
<td>1 (2)</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>No diagnosis</td>
<td>7 (14)</td>
<td>6</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>4</td>
<td>2</td>
</tr>
</tbody>
</table>

**TABLE 5.** Results of Allergy Prick Skin Tests and Sinus Radiographs by Diagnosis

<table>
<thead>
<tr>
<th>Diagnoses</th>
<th>Overall Skin Test Positive</th>
<th>Skin Test Negative</th>
<th>Sinus Radiograph Positive</th>
<th>Sinus Radiograph Negative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asthma</td>
<td>35</td>
<td>9</td>
<td>7</td>
<td>3</td>
</tr>
<tr>
<td>Sinusitis</td>
<td>5</td>
<td>0</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>Aspiration</td>
<td>2</td>
<td>0</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Recurrent cough</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>No diagnosis</td>
<td>7</td>
<td>0</td>
<td>2</td>
<td>1</td>
</tr>
</tbody>
</table>
Problematic in making such a diagnosis is the lack of definitive tests to eliminate other conditions and confirm a diagnosis of asthma in preschool-aged children. Key to diagnosing asthma in the preschool-aged child is obtaining a thorough history from parents or guardians. Although it is often difficult for parents to define symptoms precisely, and recall bias may skew responses, information from the patient’s history can assist in ruling out some conditions included in the differential diagnosis and lead to a diagnosis of asthma.

The Guidelines for the Diagnosis and Management of Asthma include exercise as an exacerbating factor, which was demonstrated by this chart review. It is important to note that in a toddler or infant, excitement, giggling, and crying are exercise equivalents. Similarly, nocturnal symptoms or awakening are more common in asthma than in other airway diseases. Nocturnal symptoms vary, however, and differentiating among them may assist the clinician in making a diagnosis as well as in determining disease severity. For example, nocturnal symptoms that result in the child’s awakening may indicate more severe disease, whereas coughing or wheezing at night with no awakening is less severe disease.

We found that snoring was positively associated with a diagnosis of asthma. Snoring in kindergarten children was investigated by Teculescu et al. Of 190 children in kindergartens in northeastern France, 19 were habitual snorers. Logistic regression analysis showed an independent relationship between snoring and exercise-induced asthma, personal history of allergy, sibling history of allergy, and tonsillar hypertrophy. The results of this study are consistent with the idea that snoring is a manifestation of diffuse airway disease related to atopy. This study supports our finding that a history of snoring is supportive of a diagnosis of asthma among the possibilities for reactive airway disease.

Sweat chloride testing, chest radiography, and allergy skin testing are cost-effective measures that provide useful diagnostic information in the preschool-aged child who wheezes. Although cystic fibrosis is relatively uncommon, its typical manifestations of airway obstruction in infants and young children mandate its consideration in children with reactive airway disease. The sweat chloride test done by the pilocarpine iontophoresis technique, which costs approximately $150, is the gold standard diagnostic test for cystic fibrosis. Ruling out cystic fibrosis as a diagnosis by performing this inexpensive test limits the differential diagnosis for reactive airway disease and often provides relief for parents.

The chest radiograph may demonstrate chronic findings consistent with, but not diagnostic of, asthma. Its most important use, however, is suggesting causes of respiratory symptoms other than asthma in the preschool-aged child, such as an aspirated foreign body, pneumonia, congestive heart failure, vascular anomalies, and pulmonary and mediastinal structures. A study in 371 children aged 1 year or older assessed the usefulness of chest radiography in making a diagnosis in children presenting to an emergency department with a first-episode wheezing. Radiography demonstrated findings compatible with a diagnosis of asthma in 350 (94.3%) of the patients. In 21 children (5.7%), other findings were evident, including segmental atelectasis and pneumonia in 7 patients, segmental atelectasis only in 6 patients, pneumonia in only 5 patients, multiple areas of subsegmental atelectasis in 2, and pneumomediastinum in 1.

Asthma that begins in childhood is commonly associated with atopy, the genetic predisposition for the development of immunoglobulin E-mediated responses to aeroallergens. In this chart review, asthma was diagnosed in all children with a positive allergy skin test. Of note, wheezing can be food-induced. This food-induced wheezing can occur with or without manifestation of GI or skin symptoms. Early allergic reactions to food, especially egg, increase the risk for later reactions to aeroallergens. The presence of eczema has been shown to be associated with an increased tendency for immunoglobulin E-mediated food allergy, and an early onset of eczema is associated with an increased risk for sensitization to aeroallergens. Thus, coupled with a thorough patient history that includes possible allergens to which the patient has been exposed and any reactions to food or history of dermatitis, allergy skin testing may provide the most definitive information to make a differential diagnosis of asthma in young children. A further discussion of the importance of atopy as a risk factor for the development of persistent asthma in young children can be found elsewhere in this supplement.

CONCLUSION

Reactive airway disease is not synonymous with asthma, but includes a broad differential diagnosis of which asthma is the most common. Making a specific diagnosis of asthma in the preschool-aged child with respiratory symptoms first requires a description of clinical features. The practitioner must think broadly about the possible causes and not make summary judgments without considering all possibilities. If one assumes that every child with reactive airway disease has asthma, then cystic fibrosis, foreign body aspiration, tuberculosis, or other possible diagnoses will be missed.

Asthma is a chronic disease, and as such, information should be sought about the nature and duration of symptoms and exacerbating factors over time. Differentiating coughing and wheezing is important because asthma is primarily a wheezing disease and other illnesses, such as sinusitis, are more commonly characterized by coughing. Whether exercise (which includes giggling and crying in a young child) exacerbates the respiratory symptoms is important to know. Similarly, information regarding nocturnal symptoms and their severity should be elicited.

Sweat chloride testing, chest radiography, and allergy skin testing should be performed in children with recurrent wheezing to rule out other causes and confirm a diagnosis of asthma. Allergy skin testing in particular provides useful information for making a differential diagnosis of asthma in the preschool-aged child.
As many as 50% of infants experience at least 1 episode of wheezing during the early years of life. Asthma will be diagnosed in one third of these children by the time they are 6 years of age. The early onset of symptoms in these children suggest that there is an opportunity to provide early treatment if a diagnosis is made when the symptoms first develop.

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