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Pseudo-asthma: When Cough, Wheezing, and Dyspnea Are Not Asthma

Miles Weinberger, MD, Mutasim Abu-Hasan

Pediatric Allergy and Pulmonary Division, Department of Pediatrics, University of Iowa, Iowa City, Iowa

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ABSTRACT

Although asthma is the most common cause of cough, wheeze, and dyspnea in children and adults, asthma is often attributed inappropriately to symptoms from other causes. Cough that is misdiagnosed as asthma can occur with pertussis, cystic fibrosis, primary ciliary dyskinesia, airway abnormalities such as tracheomalacia and bronchomalacia, chronic purulent or suppurative bronchitis in young children, and habit-cough syndrome. The respiratory sounds that occur with the upper airway obstruction caused by the various manifestations of the vocal cord dysfunction syndrome or the less common exercise-induced laryngomalacia are often mischaracterized as wheezing and attributed to asthma. The perception of dyspnea is a prominent symptom of hyperventilation attacks. This can occur in those with or without asthma, and patients with asthma may not readily distinguish the perceived dyspnea of a hyperventilation attack from the acute airway obstruction of asthma. Dyspnea on exertion, in the absence of other symptoms of asthma or an unequivocal response to albuterol, is most likely a result of other causes. Most common is the dyspnea associated with normal exercise limitation, but causes of dyspnea on exertion can include other physiologic abnormalities including exercise-induced vocal cord dysfunction, exercise-induced laryngomalacia, exercise-induced hyperventilation, and exercise-induced supraventricular tachycardia. A careful history, attention to the nature of the respiratory sounds that are present, spirometry, exercise testing, and blood-gas measurement provide useful data to sort out the various causes and avoid inappropriate treatment of these pseudo-asthma clinical manifestations.

COUGH, WHEEZING (AND other respiratory noises), and dyspnea are common respiratory symptoms that potentially have an extensive differential diagnosis.[1] Because asthma is an exceedingly common disorder, such symptoms are often a result of this recurring and chronic respiratory disorder. Although there is demonstrable underdiagnosis of asthma,[2] the purpose of this review is to increase awareness of common and uncommon entities that have resulted in inappropriate diagnoses of asthma.

WHAT IS ASTHMA?

Asthma is a disease that is characterized by hyperresponsiveness of the airways to various stimuli, which results in airway obstruction that is reversible either spontaneously or as a result of treatment. The airway obstruction is from variable components of bronchial smooth muscle spasm and inflammation that result in edema of the respiratory mucosa and mucous secretions. Although the diagnosis of asthma is frequently readily apparent, we have encountered several clinical entities that have been misdiagnosed as asthma and consequently treated inappropriately. In this review we describe these clinical entities, identify how their clinical presentation is confused with asthma, and indicate the diagnostic methods for identifying these pseudo-asthma syndromes.

WHEN IS IT NOT ASTHMA?

Asthma is diagnosed clinically and is suspected when there is cough, wheezing, or dyspnea. However, the same symptoms may be results of other causes. Although for some patients the presenting clinical picture can readily identify the problem as being something other than asthma, there can also be legitimate diagnostic uncertainty with others. The distinguishing characteristic of asthma is the response to bronchodilator or corticosteroids when the patient is symptomatic. For patients who are old enough to perform a pulmonary-function test, substantial improvement of airway obstruction from an aerosol bronchodilator or a short course of reasonably high-dose systemic corticosteroid, 2 mg/kg twice daily to a maximum of 40 mg twice daily (reduced to once daily in the morning if insomnia or irritability becomes problematic), supports diagnosis of asthma. Failure to observe substantial improvement within 5 to 7 days with complete relief of symptoms and substantial improvement in lung function after a maximum of 10 days argues against asthma as the etiology, assuming, of course, that the patient has taken the medication.

COUGH THAT IS NOT ASTHMA

Asthma is the most common cause of chronic or recurrent inflammatory airway disease and a major cause of cough. Although there are causes of cough that are unlikely to be confused with asthma, there are several that characteristically are confused with asthma and result in overdiagnosis of asthma with consequent inappropriate treatment.[3] Pertussis, known in the past as the 100-day cough, causes a prolonged period of cough, and we have seen several cases in which the primary care physician prescribed antiasthmatic medication because pertussis was not adequately considered. Characteristically spasmodic and associated with posttussive gagging or emesis, the classical clinical symptoms are often not present in an immunized population.[4-6] However, the diagnosis is important to prevent spread to contacts, and pertussis should be suspected for any cough that persists for >2 weeks in those with no previous history of asthma or other causes of chronic cough. Diagnosis is made most readily by polymerase chain reaction from a properly collected nasal swab to detect pertussis antigen.

Cystic Fibrosis

Cystic fibrosis is the second most common chronic inflammatory airway disease, at least among the white population. It occurs in ~1 in 2500 live births in populations of northern European descent with variable lesser incidence in other ethnic groups and races. Although the mechanisms of airway inflammation are different in these 2 diseases, both cause airway obstruction, cough, wheezing, and dyspnea. The classical clinical presentation of malabsorption is not always present, and the severity and progression of the airway disease is highly variable. There is a variability in the extent to which the >1500 mutations of the cystic fibrosis transmembrane regulator gene alters the chloride channel and results in clinical manifestations.[7] Consequently, some people do not present with respiratory symptoms until adolescence or even adulthood.[8] Some degree of bronchodilator response may even be present, although the physiology of the airway responsiveness differs from that in asthma.[9] Also, asthma can coexist with cystic fibrosis.

Cystic fibrosis should be suspected when symptoms and signs of airway inflammatory disease persist despite a short course of high-dose systemic corticosteroid. The diagnosis of cystic fibrosis is made most reliably by performing a sweat chloride measurement using the classical quantitative pilocarpine iontophoresis method. Most of the various screening methods that assess by the conductivity of sweat are unreliable, because they can have both false-positive and false-negative results.[10] For the test to be valid, duplicate collections of at least 75 mg are required for the filter-paper discs or gauze pads, and duplicate 15-μL samples are sufficient with the Macroduct collection coil (Wescor, Logan, UT).[11] Measurement of 60 mEq/L chloride with substantial agreement in both samples is generally diagnostic of cystic fibrosis. Sweat chloride concentrations of <40 mEq/L are generally reassuring that cystic fibrosis is not the cause of the patient's airway inflammatory disease. Levels of 40 to 60

mEq/L (>30 mEq/L for infants) should be considered sufficiently suspicious that genetic analysis should be performed for the presence of 2 mutations of the cystic fibrosis transmembrane regulator gene, of which there are now >1500.[12] Some of the less common mutations are associated with a milder course of the pulmonary disease, and a few are not associated with elevated sweat chloride levels.[7,13] Although rare (<1% of patients with cystic fibrosis), awareness of these exceptional cases of normal sweat chloride levels permit specific treatment rather than fruitless use of antiasthmatic medications that only frustrate the patient and physician.

Primary Ciliary Dyskinesia

Primary ciliary dyskinesia is rare and should be considered only when a persistent cough is present virtually from birth, generally in association with chronic otitis media.[14] A degree of neonatal respiratory distress is commonly present.[15] It includes a variety of abnormalities in airway ciliary structure and/or function that result in absence of normal mucociliary clearance, which is an important innate host-defense mechanism for the lungs. A continuous flow of the mucous layer of the respiratory mucosa is normally maintained by the coordinated rhythmic beating of ciliated respiratory epithelial cells. The absence of coordinated ciliary movement results in pooling of mucous in the airway associated with low-grade chronic infection. Cough and slowly progressing bronchiectasis result from this defect. Half will have situs inversus totalis, in which case it is known as Kartagener syndrome. As with cystic fibrosis, primary ciliary dyskinesia will not respond to usual antiasthmatic medications, and delayed diagnosis results in permanently damaged airways.

The diagnosis should be highly suspect in the presence of situs inversus totalis, but the definitive diagnosis can be difficult in the absence of that anatomic abnormality. The cough is typically present since birth on a daily basis without the fluctuating course of asthma. Chronic otitis media is another characteristic feature of the disorder. The classical means of diagnosing has been examination of ciliary structure by electron microscopy. However, this is fraught with errors in interpretation. Examination of coordinated ciliary movement from a nasal or tracheal epithelial sample by light or phase-contrast microscopy is a more practical means of initial evaluation.

Chronic Purulent (Bacterial) Bronchitis

Chronic purulent bronchitis is an entity that is not well appreciated and only infrequently described.[16] Although chronic bacterial bronchitis is certainly a characteristic of cystic fibrosis, there are young children who have no identifiable abnormalities in immunity or other underlying disease and have prolonged periods of cough with neutrophilia and bacteria in their lower airways demonstrable by bronchoalveolar lavage. Some, but not all, have bronchomalacia that may be contributing to both cough and retention of secretions in the lower airway, which predisposes the child to secondary infection (Fig 1). The bacteria identified are most commonly the same ones that are commonly associated with otitis media: *Haemophilus* species, *Moraxella catarrhalis*, and *Streptococcus pneumoniae*.[17] Although responsive to appropriate antibiotics, some will require repeated courses or even maintenance prophylactic antibiotics for an extended period. Resolution with age is common in the absence of an underlying innate or acquired host-defense disorder.
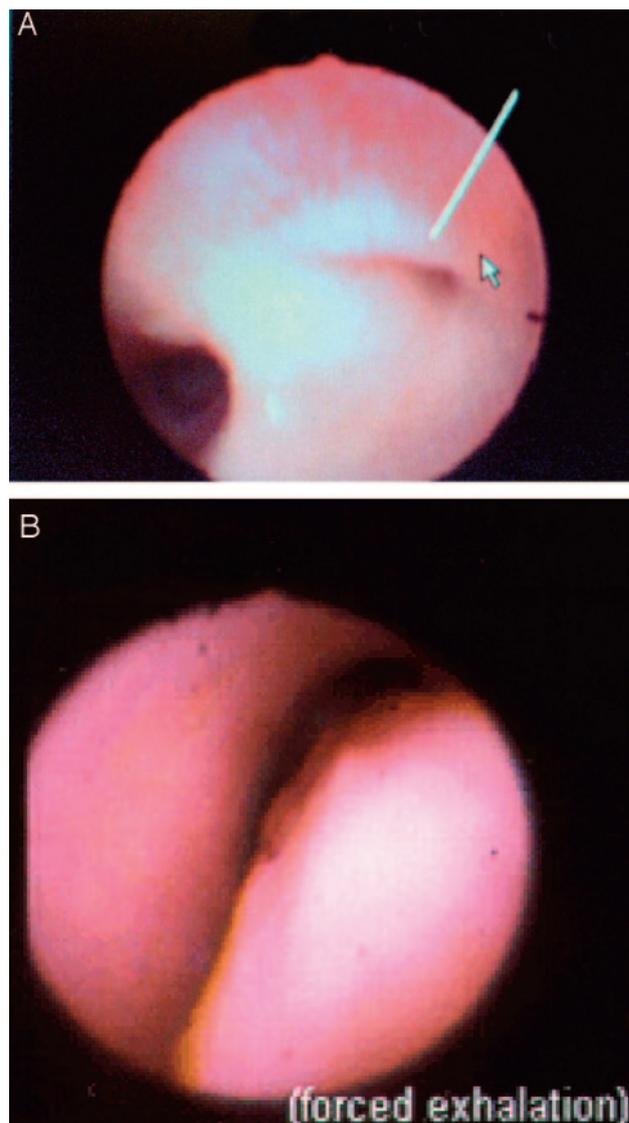

FIGURE 1
Bronchomalacia of the right upper lobe (A) and the right main stem (B). Depending on the degree of obstruction caused by the malacia, either cough or expiratory monophonic wheezing may be heard. Obstruction occurs on expiration with positive intrathoracic pressure during expiration while negative intrathoracic pressure during inspiration opens the airway. Complete airway obstruction during expiration can result in lobar emphysema from persistent hyperinflation of the lobe distal to the malacia. Decreased clearing of secretions distal to the malacia may be associated with purulent bacterial bronchitis.

Diagnosis requires flexible bronchoscopy and bronchoalveolar lavage with cell count and differential for evidence of significant neutrophilia (>10% of total white cell count) and quantitative culture of lavage fluid.

Tracheomalacia

Inadequate rigidity of the tracheal or main-stem bronchial cartilage results in tracheal collapse, which causes cough by at least 2 mechanisms (Fig 2 and Video 1, which is published as supporting information on www.pediatrics.org/cgi/content/full/120/4/855) and bronchomalacia (Fig 1). Collapse of the trachea or main-stem bronchi during increased intrathoracic pressure as in vigorous exhalation or coughing can cause the anterior and posterior walls to come into contact, which results in an irritable focus that stimulates further cough. In addition, when secretions are present in the airway, the airway collapse prevents normal airway clearance of secretions. The secretions then act as a continued stimulus for a nonproductive cough. Although tracheomalacia and bronchomalacia can be troublesome in an infant, some cases do not cause problems until later in childhood.[18] In unusually severe cases of intractable cough that result from tracheomalacia, surgical aortopexy is needed.[19] This involves placing a suture through the adventitial lining of the aortic arch and the periosteum of the sternum to pull the arch forward. Because the anterior tracheal wall is connected to the aortic arch with connective tissue, it essentially pulls the anterior wall of the trachea forward, thereby maintaining a more patent tracheal lumen.

Habit-Cough Syndrome

Habit-cough syndrome is a troublesome disorder that commonly is treated as asthma that often results in a great deal of morbidity and ineffective treatment and yet is readily curable rapidly with suggestion therapy, a simple behavioral technique.[20] The classical presentation of habit-cough syndrome is that of a harsh, barking, repetitive cough that occurs several times per minute for hours on end (see Fig 3 and Video 2, which is published online as supporting information). It is extremely irritating to those in the presence of the person who suffers from this disorder. Characteristic of the habit-cough syndrome is the complete absence of cough once the patient is asleep. Although those with this disorder are frequently subjected to multiple diagnostic tests and therapy with antiasthmatic medications, habit-cough syndrome should be readily diagnosed by the characteristic barking nature of the cough, its repetitive pattern, and complete absence once the patient is asleep.

This syndrome is sometimes misinterpreted as a tic. However, the so-called cough-tic syndrome involves more vocalization that is characteristic of Tourette syndrome and does not resemble the true cough of the habit-cough syndrome. In considering treatment and discussing the issue with the family, it is important not to refer to this as a psychogenic cough, because that is likely to adversely affect the relationship with the therapist who will subsequently need the patient's rapport to effectively use suggestion therapy. Moreover, other psychosomatic or psychological problems seem to be uncommon in these children and adolescents. Although Anbar and Hall[21] reported a high incidence of abdominal pain and irritable bowel syndrome in many of the children with habit-cough syndrome, a standardized psychological questionnaire administered to our patients subsequent to successful treatment of the habit cough

FIGURE 2
Tracheomalacia, a softening of the tracheal rings that provide a degree of rigidity to the airway, occurs as a result of either a defect in the cartilage itself or external compression by the great vessels The innominate artery (also known as the brachiocephalic trunk) crosses over the lower third of the trachea, where a pulsating bulge can often be seen on bronchoscopy. This is a common location for tracheomalacia, as in this picture and Video 1. Persistent cough occurs when the repeated contact of the anterior and posterior walls of the trachea causes a focus of irritation with a consequent harsh barking cough that is characteristic of a tracheal cough. Cough also may occur because of inefficient clearing of secretions that results from the collapse of the airway. See Video 1, which is published as supporting information on www.pediatrics.org/cgi/content/full/120/4/855.

FIGURE 3
Boy with classical repetitive, barking, habit cough that is absent once he is asleep (see Video 2).

found no other evidence for somatization, although the questionnaire revealed some tendency to score high, but not pathologically so, on an obsessive-compulsive scale.[20] Perhaps related to this personality characteristic is our observation that most of these patients were high achievers academically.

If not treated with appropriate behavioral intervention, symptoms can continue for months and years in some patients, as was demonstrated in a follow-up of diagnoses of habit-cough syndrome made at the Mayo Clinic.[22] Treatment with suggestion therapy has provided a sustained cure by the use of various techniques. In 1966, Berman described 6 patients with this disorder who were treated successfully with therapy that "relied solely on the art of suggestion."[23] Another group reported using a tightly wrapped bedsheet around the patient's chest combined with suggestion that it would stop the coughing.[24] Teaching self-hypnosis to stop the cough has been described with a high success rate with a technique that seems essentially to be a variation of suggestion therapy.[21] We have used a technique that generally results in complete cessation of symptoms within 15 minutes (Table 1).[20,25]

Other Rare Causes of Chronic Cough

We have seen some particularly unusual causes of chronic cough that were misdiagnosed as asthma. Although unlikely to be encountered frequently, awareness of these entities can encourage additional investigation when the pattern of symptoms and response to treatment is not consistent with asthma. A uvula that was in contact with the epiglottis was the cause of a long-standing cough in a 4-year-old boy who was treated unsuccessfully for asthma.[26] This could be visualized only during flexible fiber-optic bronchoscopy while the patient was lying on his back. The child related that he coughed because he felt something in the back of his throat. His cough was cured with uvulectomy. Tonsils impinging on the uvula of a 3-year-old girl were seen on bronchoscopy with a long-standing chronic cough that initially was treated as asthma (Fig 4). Tonsillectomy cured the cough in that patient and another patient with similar findings.

On the other hand, cough is often attributed to gastroesophageal reflux or postnasal drip, termed by some as upper airway cough syndrome.[27] However, this diagnosis is infrequently supported by objective evidence.[28] When bronchoalveolar lavage was performed as part of a diagnostic study for protracted cough in children, neither the so-called upper airway cough syndrome nor gastroesophageal reflux were common diagnoses. Postnasal mucus certainly may be visualized in the posterior oral pharynx, but there is considerable skepticism that this is a cause of true cough rather than just throat-clearing for some.[29,30] Similarly, because gastroesophageal reflux can result from coughing,[31] there is an ongoing debate with inconclusive evidence regarding this chicken-and-egg question.[32]

TABLE 1	Major Elements of a 15-Minute Suggestion-Therapy Session for Habit-Cough Syndrome

Expressing confidence, communicated verbally and behaviorally, that the therapist will be able to show the patient how to stop the cough

Explaining the cough as a vicious cycle of an initial irritant, now gone, that had set up a pattern of coughing that caused irritation and additional symptoms

Encouraging the suppression of cough to break the cycle (the therapist closely observes the patient for initiation of the muscular movement that precedes coughing and immediately exhorts the patient to hold the cough back, emphasizing that each second the cough is delayed makes further inhibition of cough easier)

Offering an alternative behavior to coughing in the form of inhaling a generated mist or sipping body-temperature water with encouragement to inhale the mist or sip the water every time the patient begins to feel the urge to cough

Repeating expressions of confidence that the patient is developing the ability to resist the urge to cough

When some ability to suppress cough is observed (usually after ~10 min), asking in a rhetorical manner if the patient is beginning to feel that he or she can resist the urge to cough (eg, "You are beginning to feel that you can resist the urge to cough, aren't you?")

Discontinuing the session when the patient can repeatedly answer positively to the question, "Do you feel that you can now resist the urge to cough on your own?" (this question is only asked after the patient has gone 5 min without coughing)

Source: Lokshin B, Lindgren S, Weinberger M, Koviach J. *Ann Allergy*. 1991;67:579–582.
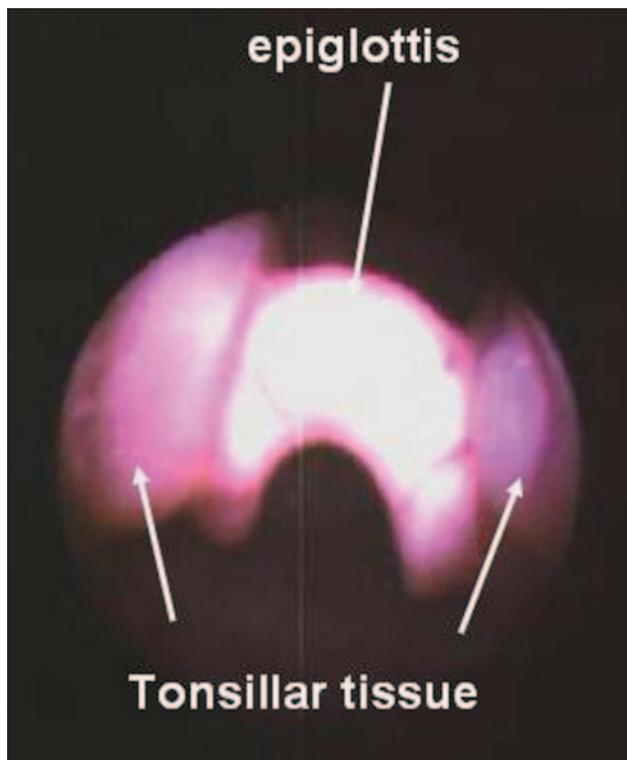

FIGURE 4
Tonsils (the lateral masses in the image) impinging on the epiglottis in a 3-year-old girl caused chronic cough that initially was treated unsuccessfully as asthma. A tonsillectomy cured her cough.

WHEEZING THAT IS NOT ASTHMA

In considering wheezing, it is important to appreciate that patients, parents, and even physicians at times refer to various respiratory sounds as "wheezing" that are not, in fact, wheezing.[33–35] Wheezing is defined as a continuous musical expiratory sound caused by intrathoracic airway obstruction. However, parents will describe inspiratory rattling or stridor as wheezing, and there are many reports of inspiratory sounds from upper airway obstruction being called wheezing by medical personnel and misdiagnosed as asthma.[36]

Vocal Cord Dysfunction

Vocal cord dysfunction can occur for various reasons including brainstem compression from a Chiari 1 malformation or vocal cord paralysis from various causes.[37]

Vocal cord dysfunction syndrome is a functional disorder of the vocal cords. It is commonly misdiagnosed as asthma on the basis of an inappropriate description of "wheezing."[36] The respiratory noise, however, is actually a high-pitched inspiratory stridor caused by paradoxical adduction of the vocal cords during inspiration. This is reflected in a spirometry tracing by a blunting of the inspiratory portion of the flow-volume loop with a normal expiratory portion indicating upper airway obstruction (Fig 5A and Video 3, which is published online as supporting information). A less common variation of vocal cord dysfunction syndrome manifests itself as abnormal continuous inspiratory and expiratory sounds. This latter variation of vocal cord dysfunction syndrome is characterized by spasmodic closure of the vocal cords with adduction that persists during both inspiration and expiration and results in marked blunting of both the inspiratory and expiratory loops on spirometry, which indicates a fixed upper airway obstruction (Fig 5B and Video 4, which is published online as supporting information).

Two phenotypes of vocal cord dysfunction syndrome have been described.[38] One type occurs spontaneously, with the patient experiencing dyspnea and inspiratory stridor (often described as "wheezing") at various and often unpredictable times. Whether this is a panic- or anxiety-induced reaction is speculative. Nonetheless, it is alarming for those who experience the reaction and for those who observe it. Urgent visits to an emergency department are common, and those who have spasmodic closure of the vocal cords are more likely than those with just paradoxical movement to experience multiple emergency 911 calls because of the alarming appearance of their respiratory distress. The other phenotype is a reaction that occurs only with exercise, which is commonly seen in adolescent athletes during competitive aerobic activities. Typically transient and relieved spontaneously with a period of rest, this phenotype of vocal cord dysfunction syndrome is troublesome predominantly because it interferes with athletic
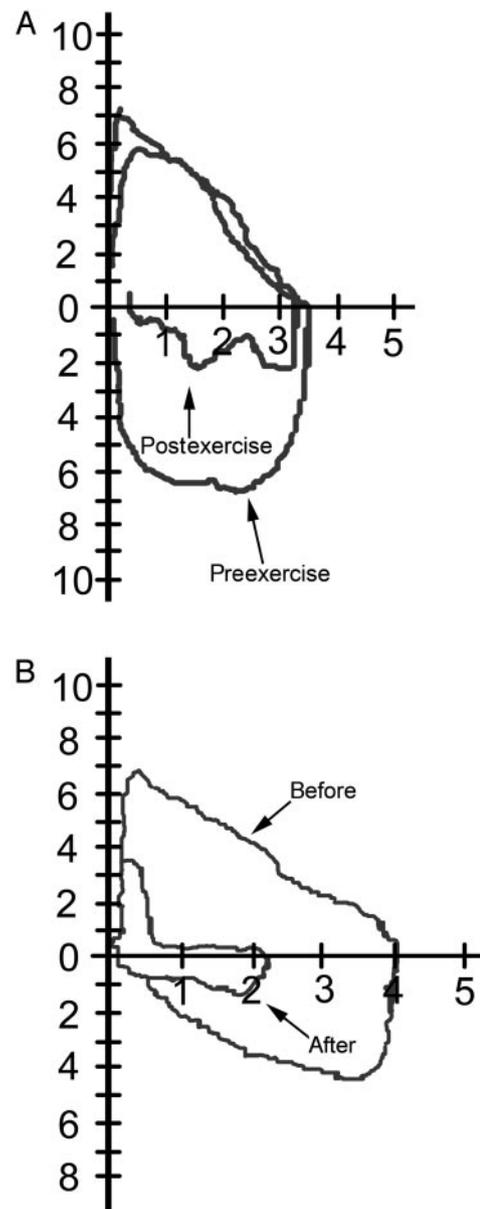

FIGURE 5
Flow-volume loops obtained before and when symptomatic for 2 patterns of vocal cord dysfunction syndrome. A, Preexercise flow-volume loop with the midinspiratory and midexpiratory flows approximately equal and the postexercise loop exhibiting the typical flattening of the inspiratory portion of the flow-volume loop in a 15-year-old girl with exercise-induced inspiratory stridor that had been described as "wheezing" by previous physicians (see Video 3). This indicates reversible upper airway obstruction that was then confirmed by visualizing adduction of the vocal cords on inspiration with flexible laryngoscopy. B, Flow-volume loops from a 15-year-old girl with a history of repeated episodes of sudden-onset severe dyspnea. She had spontaneous onset of severe dyspnea during our initial evaluation with marked compromise of both inspiration and expiration illustrated by the spirometric tracing. Flexible laryngoscopy demonstrated the vocal cords and false vocal cords to be severely adducted, leaving only an ~2-mm opening for air movement except when talking (see Video 4).

activities. Although most patients with vocal cord dysfunction syndrome will manifest only 1 of these 2 patterns, some will exhibit both patterns.[38]

Diagnosis of vocal cord dysfunction requires seeing the patient while he or she is symptomatic and differen-

tiating upper from lower airway obstruction. Performance of spirometry in the emergency department setting is essential to avoid the common misdiagnosis of asthma, as has been reported in the past.[36,38] The spirometric demonstration of a decrease in the ratio of the forced midinspiratory flow (FIF_{50}) to the forced midexpiratory flow (FEF_{50}), which should be ≥ 1, is visually evidenced by a flattening of the inspiratory portion of the flow-volume loop. This indicates upper airway obstruction, which could include other causes such as subglottic stenosis and vocal cord paralysis. Flexible fiberoptic laryngoscopy or bronchoscopy while the patient is symptomatic is then essential to confirm the diagnosis of vocal cord dysfunction.

Demonstrating a fluctuating course distinguishes vocal cord dysfunction from vocal cord paralysis, which can also cause paradoxical vocal cord movement.

Treatment for the spontaneously occurring phenotype of vocal cord dysfunction syndrome is instruction by a speech pathologist who is familiar with this disorder in techniques to voluntarily take control of the vocal cords, which is generally effective. Such techniques, however, are not practical for those with exercise-induced vocal cord dysfunction, because the techniques would require stopping the athletic activity that was inducing the problem, which results in spontaneous resolution of symptoms anyway. We have observed that an anticholinergic aerosol (Atrovent oral inhaler), when used before exercise, prevents vocal cord dysfunction in these patients. This observation is consistent with evidence that a vagal reflux is involved in this pattern of vocal cord dysfunction.[39–41] For both patterns of vocal cord dysfunction syndrome, the long-term outlook for resolution or accommodation seems favorable.[38]

Exercise-induced laryngomalacia can mimic exercise-induced vocal cord dysfunction, but the airway obstruction on inspiration is from invagination of the arytenoids rather than from paradoxical vocal cord movement.[42–45] Flexible laryngoscopy at the time symptoms are reproduced is essential to distinguish the relatively rare exercise-induced laryngomalacia from the more common exercise-induced vocal cord dysfunction.

Partial Airway Obstruction

A cause of true wheezing, partial obstruction of a bronchus can result in wheezing that is commonly misdiagnosed and treated as asthma. A retained foreign body in a bronchus is one cause and needs to be distinguished from a mucous plug associated with asthma that also can obstruct a bronchus. Another is bronchomalacia (Fig 1).[46,47] Most commonly associated with wheezing in infants, bronchomalacia is associated with little respiratory distress.

In contrast to a mucous plug from asthma or other airway inflammatory disease, these causes of partial airway obstruction will cause unilateral wheezing that is persistent, whereas the localized wheezing from a mucous plug may vary from time to time as the patient coughs and changes locations of partial airway obstruction from mucous.

Both tracheomalacia and bronchomalacia can be missed during rigid bronchoscopy in which general anesthesia and positive-pressure ventilation keep the airway open. It is during flexible bronchoscopy with conscious sedation and spontaneous respiration that malacia of the intrathoracic airways is most likely to be seen. The natural course of bronchomalacia is resolution with age, apparently as the airway increases in size. It is not known how many subsequently become associated with cough as described by Wood.[18]

DYSPNEA THAT IS NOT ASTHMA

Hyperventilation

Attacks of hyperventilation can be confused with asthma, in both those who have asthma and those who do not.[48] We have observed that patients who have both asthma and experience hyperventilation attacks cannot readily distinguish the sensation of dyspnea associated with hyperventilation from that associated with their asthma. Spirometry at the time the patient is symptomatic can help distinguish the perception of dyspnea associated with a hyperventilation attack from asthma. In the presence of normal pulse oximetry during ambient air respiration, blood-gas measurement that demonstrates low P_{CO_2} and high pH at the time of symptoms provides supportive evidence for hyperventilation.

Anxiety

Dyspnea is a perception of difficulty in breathing. Patients may relate that they have trouble taking a breath or that they have tightness in their chest in the absence of any identifiable physiologic disorder. Using an anxiety-sensitivity index, Simon et al[49] demonstrated that anxiety plays an important role in the experience of dyspnea, independent of any physiologic respiratory disorder.

Exertional Dyspnea

Dyspnea on exertion in children and adolescents is frequently part of the clinical course of asthma. However, asthma is rarely the diagnosis when there is dyspnea on exertion with no respiratory symptoms other than during exercise.[50,51] In a study of 142 children and adolescents with exercise-induced dyspnea referred to us, 100 had been previously diagnosed with and treated for asthma without clinical response. When treadmill exercise was performed with cardiopulmonary monitoring on 112 of the 142 (Fig 6), exercise-induced bronchospasm was rare despite having reproduced the patient's exercise-induced dyspnea.[50] The most common cause of exercise-induced dyspnea was physiologic limitation in

FIGURE 6

Exercise test with cardiopulmonary monitoring. Continuous measurement is provided for inspiratory and expiratory flow, oxygen utilization, carbon dioxide production, electrocardiography, and pulse oximetry during progressive treadmill exercise until the patient's symptoms are reproduced. A blood-gas measurement is routinely obtained at the completion of the test.

crease in respiratory drive is perceived as dyspnea by these patients. Other abnormalities documented included vocal cord dysfunction, restrictive physiology associated with minor chest wall abnormalities, exercise-induced laryngomalacia,[45] exercise-induced hyperventilation,[52] and exercise-induced supraventricular tachycardia (Fig 7).

Making the correct diagnosis by treadmill exercise with cardiopulmonary monitoring including gas exchange enables the cessation of ineffective asthma pharmacotherapy and appropriate corrective action. Moreover, by providing an explanation for the patient's exercise-induced dyspnea, the anxiety typically associated with the dyspnea can generally be relieved. For those with physiologic dyspnea, counseling regarding conditioning and appropriate training can be of considerable value.

CONCLUSIONS

Although asthma is a common cause of various respiratory symptoms, all that coughs, wheezes, and causes shortness of breath or dyspnea is not asthma. Knowledge of the natural history of asthma and close observation of the response to therapy should quickly lead to an index of suspicion that diagnoses other than asthma need to be considered. Appropriate diagnostic tests including spirometry when symptomatic, flexible bronchoscopy with conscious sedation rather than general anesthesia, bronchoalveolar lavage, and treadmill exercise testing with cardiopulmonary monitoring can generally result in the appropriate diagnosis and more specific treatment.
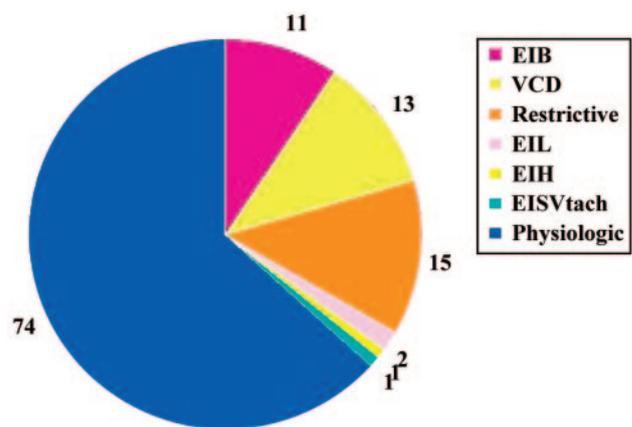

FIGURE 7

Diagnoses among 117 children and adolescents who underwent treadmill exercise testing with a progressive incline and duration until symptoms were reproduced during cardiopulmonary monitoring. Although most had been previously diagnosed and treated for asthma, exercise-induced bronchospasm (EIB) was present in only 11 of the children. Vocal cord dysfunction (VCD) was associated with the reproduced dyspnea on exertion in 13 children, 15 had evidence of chest wall restriction associated with minor degrees of pectus deformities and scoliosis (Restrictive), 2 had exercise-induced laryngomalacia (EIL), 1 had exercise-induced hyperventilation (EIH),[52] and 1 had exercise-induced supraventricular tachycardia (EISVtach). The majority of the children (74) had physiologic dyspnea (Physiologic); approximately one third of them were highly motivated, well-conditioned athletes, and one third had below-average cardiovascular conditioning.[50]

patients with a wide range of cardiovascular conditioning. Their perception of dyspnea resulted from the lactic acidosis–induced respiratory drive that occurs during anaerobic metabolism when exercise exceeds what is commonly called the anaerobic or ventilatory threshold. The lowered pH from the metabolic acidosis stimulates the attempt to compensate by increasing respiratory drive in an attempt to raise the pH by reducing P_{CO_2}. This in-

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RUBBER DUCKY FRENZY

"As if we didn't have enough real problems to worry about, an international media frenzy has erupted over a flotilla of 'yellow rubber duckies' from the Pacific Ocean. The ducks are supposedly about to storm the beaches of the British Isles, 15 years after they spilled off a container ship 10,000 miles away. Reporters from Scotland, England, Germany, several other EU countries, Canada, Brazil, Australia, New Zealand, Japan and the US have been emailing me urgent questions about the ducks: Have they been sighted in Britain yet? When will they land, and where? I have been tracking these wayward bathtub toys for 15 years, with the help of an international network of dedicated beachcombers. We have collected data on these floaters—where they beach, and when—in order to better understand the oceans' currents: where they flow, how fast they flow, and how and when they interconnect. . . . The 29 000 celebrated bathtub toys that fell into the Pacific in January 1992 aren't made of rubber, they're plastic. . . . Their 11-year journey began in the central Pacific, about where the International Date Line crosses the 45th parallel. They proceeded eastward to southeast Alaska, where beachcombers recovered thousands of their fellows. From there, the two toys drifted north to the Bering Sea, across the North Pole, south along eastern Greenland, and further south to Newfoundland, where their paths diverged—one to Maine and the other to Britain. To complete these journeys, they had to ride four circular oceanic currents called 'gyres' or 'carousels of the seas.' To understand these gyres, we have also tracked 80 000 Nike shoes lost in another North Pacific cargo spill (each one bearing a code for the container from which it spilled), 34 000 spilled hockey gloves, five million Lego pieces lost off England's Land's End and Japanese survey stakes that typhoons have washed out into the Pacific. . . . By roaming the world's beaches and seeing what washes up, we have also learned that there is far too much man-made stuff floating on the seas, especially stuff made out of plastic—now found in eight vast oceanic garbage patches. Most of it does not biodegrade. It just breaks down into ever smaller pieces, to the size of confetti and, finally, dust. Fish, birds and other marine animals eat this pseudo-plankton and pass it up the food chain. Our world-wide litter is poisoning the seas, the creatures within them, and ultimately, our-selves. . . . These humble toys have piqued curiosity and stimulated imaginations around the world, but they can also yield important scientific data. If you spot one of the bathtub toys, please take a picture, look for the words 'The First Years' imprinted on each toy (see photos at www.beachcombers.org), and send a note to curtisebbesmeyer@comcast.net. You might also consider joining the beach-combers who patrol and clean our shorelines. You can help us better understand and protect our magical but fragile oceans and their powerful, circulating currents."

Ebbesmeyer C. *Wall Street Journal.* **August 3, 2007**
Noted by JFL, MD

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Pseudo-asthma: When Cough, Wheezing, and Dyspnea Are Not Asthma

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