Chronic Cough in Children
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Abstract

Cough is probably the most common cause of seeking medical care in pediatric practice. Most acute cough is caused by infection and usually resolves within less than 4 weeks. If it lasts longer, it is considered chronic and deserves investigation to identify the underlying cause, which can be almost any of a wide variety of illnesses of the respiratory tract and certain extrathoracic conditions. This review provides an optimal approach for diagnosis through a skillful history taking, physical examination, and selection of appropriate tests. [Pediatr Ann. 2014;43(8):e176-e183.]
Coughing is generally seen as a symptom of illness, but it is the most efficient mechanism for clearing the airways and is actually a component of an innate defense mechanism. Hence, impairment or suppression of this mechanism might be harmful. Nearly all conditions affecting the respiratory tract and some extrathoracic conditions may cause coughing; hence, the main task is to diagnose the underlying disease. Normal children cough an average of 11 times a day, more during the cold seasons than the warm ones.¹

**DEFINITION**

Most cough caused by acute respiratory infection in children resolves within a few weeks. There is no consensus on the cutoff duration of cough for it to be considered chronic. The American College of Chest Physicians Guidelines² and the Thoracic Society of Australia and New Zealand³ define chronic cough as lasting more than 4 weeks. On the other hand, the British Thoracic Society defines it as a duration of more than 8 weeks.⁴ In 2 studies on children,⁵,⁶ cough did not resolve by 8 weeks in 80% of cases, indicating that a cutoff duration of 8 weeks may be too long.

**COUGH REFLEX**

The cough reflex involves cough receptors, mediators of sensory nerves and an afferent pathway (the vagus nerve), the cough center in the brain stem, an efferent pathway, and the effector respiratory muscles.⁷ Cough can be mechanically or chemically stimulated, either endogenously (by airway secretions or mediators of inflammation) or exogenously by various irritants (eg, aspirated foreign materials, environmental pollutants) or noxious agents (eg, capsaicin, citric acid). The efferent limb of the cough pathway includes the recurrent laryngeal nerve and the spinal nerves. The main effectors are the glottis and muscles of expiration (ie, the abdominal wall, dia- phragm, and intercostal muscles). There are three possible cough receptors in the lung for the rapidly conducting A delta sensory fibers (myelinated) located in the airway epithelium, pulmonary C fibers (nonmyelinated) in the alveoli, and bronchial C fibers in the airway wall.

In 2.3% to 4.2% of people, an auricular branch of the vagus nerve is present, unilaterally or bilaterally, as an accessory, and its mechanical stimulation provokes the ear-cough reflex. Cases of chronic cough have been reported secondary to foreign body in the ear canal, earwax impaction, cholesteatoma, and aberrant sensory nerve regeneration after surgery on the neck or chest.²

**EPIDEMIOLOGY**

Chronic cough is probably the most common symptom of patients seeking medical care worldwide. Epidemiologic studies of cough in children have been hampered by the variable definitions used for defining chronicity, the presence of other concomitant symptoms (eg, wheezing), the lack of widely accepted objective clinical endpoints to measure cough severity, and the tendency for cough to resolve spontaneously.

According to studies using parent-completed questionnaires, cough without wheeze or upper respiratory infection was reported in 10% of a group of children aged 7 to 9 years⁸ and in 22% of preschool-aged children.⁹ In a report from the United Kingdom, 30% of all pediatric (6 months to 6 years) primary care encounters were due to respiratory illnesses, with cough accounting for more than 8% of all presentations.¹⁰ In the United States, cough in general is the fourth leading cause for emergency department visits across all ages and accounts for 3% of all presentations.¹¹

**DIAGNOSTIC APPROACH**

Cough is primarily a defense mechanism but can be a symptom of disease. The diagnosis should focus on the underlying cause and may range from a simple nonspecific cough that resolves spontaneously to serious causes such as foreign bodies, cystic fibrosis, and bronchiectasis. Some experts have classified cough in children into the following categories: (a) expected, because normal children may cough several times a day without illness; (b) nonspecific dry cough with normal chest radiograph; or (c) specific cough (wet or dry) that may be associated with abnormal chest examination or chest radiograph, dyspnea, hemoptysis, recurrent pneumonia, failure to thrive, or swallowing problems.¹²

**Medical History**

Valuable clues can be derived from the age of onset and initial symptoms. Onset during the neonatal period and early infancy should prompt consideration of congenital malformations (eg, tracheobronchomalacia), conditions predisposing to aspiration (eg, tracheoesophageal fistula, laryngeal cleft, or neuromuscular disorder), or chronic pulmonary disease (eg, bronchopulmonary dysplasia or cystic fibrosis). A cough that begins suddenly while playing or eating, especially in the toddler age range, should raise suspicion of an aspirated foreign body in the airway.

The initial choking may have occurred weeks before evaluation, and the family may not recall detailed information.

The cough characteristic may point to a specific underlying disease (Table 1). Cough following exercise or exposure to cold air, allergens, or nonspecific irritants should suggest asthma. Chronic productive cough indicates a suppurrative process such as bacterial infection, bronchiectasis, cystic fibrosis, immune deficiency, or congenital malformation. In a study of children presenting with chronic cough, a wet-moist quality to the cough was the most useful clinical marker of a specific underlying disease.¹³

Cough during sleep can be due to postnasal drip, gastroesophageal reflux,
or exposure to allergens in bed. On the other hand, cough due to bronchiectasis is typically worst and most productive early in the day. Cough triggered during swallowing should suggest aspiration, either primary or due to tracheoesophageal fistula, laryngeal abnormalities, or neuromuscular disease. Habit (psychogenic) cough is present during the day, disappears at night, and is worst in the presence of adults or during school.

History of hemoptysis should be taken seriously. It may reflect bronchiectasis, cavitary lung disease (eg, tuberculosis or bacterial abscesses), heart failure, hemosiderosis, neoplasm, foreign bodies, vascular lesions, endobronchial lesions, or clotting disorders. Cough associated with malabsorption or failure to thrive should raise suspicion of cystic fibrosis or immune deficiency.

When obtaining medical history, there may be a need to go back as far as information on the perinatal period. Prematurity and neonatal respiratory distress syndrome are precursors for bronchopulmonary dysplasia, which may cause persistent respiratory symptoms in children and adolescents. Children with a history of infantile eczema are at high risk of respiratory allergy and asthma. Past severe respiratory infection, particularly if caused by pertussis or adenovirus, may have predisposed children to subsequent development of bronchiectasis, bronchiolitis obliterans, or chronic lung disease.

**Family History**

The presence of atopy or asthma in either parents or siblings alerts to possible respiratory allergy in the child. Chronic or current respiratory illness in family members or close contacts should alert to a perpetuation of infection that is chronic in nature, such as tuberculosis. Information about the family structure and dynamics might reveal factors that may contribute to the cough chronicity or even the cause (eg, psychogenic cough).

**Environmental History**

Inquiry should be made about indoor exposure to furry pets, smoke (eg, tobacco, marijuana, or cocaine), wood-burning stoves, or chemical irritants. Also, damp areas at home allow mold growth. Echinococcosis is contacted through exposure to dogs and sheep.

Physicians should be aware of certain infections (fungal or parasitic) endemic to particular geographic areas. Histoplasmosis is found worldwide but particularly in North and Central America. Within the United States, infection is most common in the Midwestern states located in the Ohio and Mississippi River Valleys. Residents of the Southwestern United States, Northern Mexico, and parts of Central and South America are at risk for coccidiomycosis.

**PHYSICAL EXAMINATION**

Characteristics of the cough should be observed during the interview (Table 2). The child’s general appearance may reflect chronic illness, poor growth, thinness, obesity, hoarseness of voice, finger clubbing, increased work of breathing, retractions, accessory muscle use, chest hyperinflation, or chest wall deformity. Low muscle tone, particularly in infants, may be associated with feeding difficulties or reflect specific neuromuscular conditions. Similarly, craniofacial and palatal abnormalities can be associated with swallowing dysfunction. It is also

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**TABLE 1.**

**Obtaining Medical History of Chronic Cough**

| Onset: When did the cough start and were there any specific circumstances? |
| Nature: Initially, progress, and current |
| Impact on: Normal activity, exercise, socialization, schooling, sleep |
| Relationships: Exercise, emotional stress, environmental triggers, lying down, sleep |
| Course: Spontaneous or response to interventions (medications, environmental changes) |
| Associated symptoms: Fever, night sweats, breathing difficulty (with or without exertion), weight loss |
| Comorbid conditions: Swallowing difficulties, heart disease, neuromuscular disorders |
| Perinatal history: Prematurity, neonatal illness, interventions |

**TABLE 2.**

**Characteristics of Chronic Cough and Their Etiologic Significance**

<table>
<thead>
<tr>
<th>Characteristic of Cough</th>
<th>Underlying Condition</th>
</tr>
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<tbody>
<tr>
<td>Honking, disappears during sleep</td>
<td>Habit (psychogenic) cough</td>
</tr>
<tr>
<td>Nocturnal</td>
<td>Asthma, rhinosinusitis</td>
</tr>
<tr>
<td>Exercise-related</td>
<td>Asthma, cystic fibrosis, bronchiectasis</td>
</tr>
<tr>
<td>With stridor</td>
<td>Laryngeal obstruction, foreign body, pertussis</td>
</tr>
<tr>
<td>Paroxysmal or spasmodic with inspiratory whoop</td>
<td>Pertussis</td>
</tr>
<tr>
<td>Staccato</td>
<td>Chlamydia pneumonia</td>
</tr>
<tr>
<td>Barking or brassy</td>
<td>Croup, laryngitis, tracheitis, tracheomalacia, habit or psychogenic</td>
</tr>
<tr>
<td>Productive with purulent expectoration, worse in the morning</td>
<td>Chronic bronchitis, cystic fibrosis, bronchiectasis</td>
</tr>
</tbody>
</table>

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important to pay particular attention to the head and neck for halitosis, allergic nasal crease, swollen nasal turbinates, nasal obstruction, nasal polyps, tonsillar hypertrophy, pharyngeal cobble-stoning, and high arched or cleft palate. Check for wax in the external auditory meatus and the tympanic membrane for scarring or otorrhea. A careful chest auscultation may reveal chest deformity, abnormal breath sounds, or reduced or asymmetrical air entry. Common symptoms and signs that may suggest certain underlying causes are summarized in Table 3.

**CAUSES OF CHRONIC COUGH**

Infection

Prolonged respiratory infection or sequelae of respiratory infection is a common cause of nonspecific persistent cough. It is due to increased cough receptor sensitivity and airway hyper-reactivity that can last 8 weeks or more. In patients present with dry cough, it may be associated with dyspnea, wheeze, reversible airway obstruction, or positive methacholine bronchial challenge.

Chronic cough can be simply caused by postnasal drip secondary to infectious or allergic rhinosinusitis, which is often misdiagnosed in children. Chronic wet cough with purulent sputum indicates bacterial infection, most commonly with *Streptococcus pneumonia*, *Haemophilus influenza*, and *Moraxella catarrhalis.*

Whooping cough, mostly indicative of infection with *Bordetella pertussis*, is characterized by a harsh, nonproductive, spasmodic cough that substantially interferes with sleep and is often associated with post-tussive emesis. With recovery from the acute illness, the paroxysms become milder and occur less frequently, but coughing may persist for several weeks. If secondary infection develops, recurrent paroxysms of coughing and whoops may reappear for several months. In one study, one-third of children aged older than 5 years with prolonged coughing were found to have pertussis, with a median duration of cough approaching 4 months. Other infectious agents associated with chronic cough are *Mycoplasma*, rhinovirus, and respiratory syncytial virus.

**Asthma**

Asthma is the most common chronic disease in children, affecting approximately 1 in 10. However, the majority of children with isolated cough do not have asthma. In some children, chronic cough may be an early stage or mild form of asthma (cough-variant asthma). Spirometry may be normal, but airway hyper-reactivity can often be documented. The most efficient test to identify chronic cough as a manifestation of asthma is 7 to 10 days of oral corticosteroids.

Acute asthma episodes can be associated with paroxysmal cough severe enough to cause cough syncope. The generated high intrathoracic pressure causes venous obstruction, decreased venous return, and decreased cardiac output, causing transient cerebral hypoxia and syncope. The face becomes red, and the child perspires and becomes agitated. Recovery generally occurs within seconds or a few minutes.

### Table 3.

**Possible Significance of Symptoms and Signs in Patients with Chronic Cough**

<table>
<thead>
<tr>
<th>Symptoms/Signs</th>
<th>Possible Underlying Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Symptoms</strong></td>
<td></td>
</tr>
<tr>
<td>Daily expectoration</td>
<td>Suppurative lung disease</td>
</tr>
<tr>
<td>Feeding difficulties</td>
<td>Any serious systemic including pulmonary illness, aspiration</td>
</tr>
<tr>
<td>Hemoptysis</td>
<td>Suppurative lung disease, vascular lesion</td>
</tr>
<tr>
<td>Recurrent pneumonia</td>
<td>Immunodeficiency, atypical infections, suppurative lung disease, congenital lung abnormalities, tracheo-esophageal fistulas</td>
</tr>
<tr>
<td>Swallowing difficulty</td>
<td>Craniofacial or palatal abnormalities</td>
</tr>
<tr>
<td>Exertional dyspnea</td>
<td>Substantial airway or pulmonary parenchymal disease, cardiac disease</td>
</tr>
<tr>
<td>Chest pain</td>
<td>Pleural disease, cardiac arrhythmia</td>
</tr>
<tr>
<td><strong>Signs</strong></td>
<td></td>
</tr>
<tr>
<td>Failure to thrive</td>
<td>Cystic fibrosis, other chronic pulmonary disease</td>
</tr>
<tr>
<td>Tachypnea or dyspnea</td>
<td>Substantial airway or pulmonary parenchymal disease</td>
</tr>
<tr>
<td>Cyanosis</td>
<td>Any airway or parenchymal disease, cardiac disease</td>
</tr>
<tr>
<td>Digital clubbing</td>
<td>Suppurative lung disease, cyanotic heart disease</td>
</tr>
<tr>
<td>Lymphadenopathy</td>
<td>Neoplastic disease, tuberculosis</td>
</tr>
<tr>
<td>Chest wall deformity</td>
<td>Any pulmonary airway or parenchymal disease</td>
</tr>
<tr>
<td>Lung auscultation</td>
<td>Wheeze from lower airway obstruction, rhonchi from secretions, crepitations from alveolar secretions, decreased breath sound from consolidation or atelectasis</td>
</tr>
<tr>
<td>Cardiac abnormalities</td>
<td>Associated airway abnormalities, cardiac failure</td>
</tr>
<tr>
<td>Neuromuscular disease</td>
<td>Aspiration lung disease</td>
</tr>
</tbody>
</table>

Adapted from Shields and Doherty* and Chang and Glomb*
Retained Foreign Body

Most foreign bodies aspirated into the respiratory tract are expelled immediately by forceful reflex cough and never require medical attention. The initial symptom is often followed by a symptom-free interval that may last hours to weeks. Small objects that lodge in one of the mainstem or lobar bronchi cause chronic and usually less severe symptoms. If the acute episode is mild or transient, it may be neglected by the parents, and the child may continue to have recurrent or chronic cough or wheezing. Some patients may develop chronic pulmonary disease.

The degree of obstruction and the stage at which the patient is seen determine the observed symptoms and physical findings. Breath sounds are decreased on the side of the obstruction, but this may not be obvious if there is diffuse wheezing. Wheezing is usually ipsilateral, but in some cases a reflex bronchospasm may occur on the other side as well. In a series of children with a foreign body in the airway, cough was present in 70% of patients, decreased breath sounds in 53%, wheezing in 45%, and choking episodes in 32%.

Chest radiographs may reveal a distal atelectasis or area of hyperinflation, but the foreign body may not be radiopaque. A foreign body may only be identified by bronchoscopy, which may need to be done more than once. Occasionally, a foreign body is not diagnosed until it is revealed by examination of a damaged lobe that has been resected.

Rhinosinusitis

Postnasal drip secondary to chronic allergic or infectious rhinosinusitis is a relatively common cause of cough that acts as a defense mechanism. Nasal stuffiness is common in infants but is often neglected. Also, allergic rhinitis is often underdiagnosed in children. In a series of children with cough lasting longer than 1 month, 65% had abnormal Water’s view sinus radiographs, and treatment of sinusitis resulted in resolution of cough in 82%.17

Allergic Cough

Allergy may be the underlying cause of chronic or recurrent dry cough without wheezing. It should be considered in the absence of an obvious cause of cough and in the presence of clinical or laboratory evidence of atopy. Helpful clues are either seasonal variation of symptoms or exacerbation of symptoms on exposure to certain indoor or outdoor allergens. Allergy skin testing (or serum-specific immunoglobulin E [IgE] testing) often reveals the culprit allergen. A trial of an antihistamine is worthwhile.

Habit Cough

Children who cough as often as several times a minute with regularity are likely to have a habit cough. Typically, the cough is repetitive, dry, loud, harsh, and barking or honking in nature. It increases with attention but decreases in the absence of adults or with involvement in activity, and it disappears during sleep. In some cases, the cough is softer and has the appearance of a repetitive sound or throat clearing. Interestingly, the cough usually ceases when the child is asked to stop coughing for a while to auscultate the chest.

Parents are usually worried and take the child to multiple doctors, who often order laboratory tests and radiologic studies that show normal findings. Such children are usually prescribed various cough medications and antibiotic courses, without significant improvement. Habit cough should be differentiated from Tourette syndrome, which is characterized by multiple motor tics including at least one vocal tic that may resemble a cough. The designation habit cough is preferable to psychogenic cough. Habit cough carries no stigma, and most of these children do not have significant emotional problems. When the cough disappears, it does not reemerge as another symptom. Management consists of psychological evaluation and behavior modification therapy.18

Cystic Fibrosis

Children whose cough persists longer than 6 weeks are worth testing for cystic fibrosis (CF), particularly if there is malabsorption, failure to thrive, or a positive family history. CF is the most common life-threatening autosomal-recessive disease in the United States, occurring in approximately 1 in 3500 newborns.19 The diagnosis should be confirmed by sweat chloride testing. If the sweat test is negative or borderline, genetic testing for the CF gene mutation is needed.

Tracheomalacia

Congenital tracheomalacia is caused by a weakness of cartilage in the tracheal wall. Floppiness of the trachea leads to high-pitched breathing or chest rattling, which worsens with crying or concurrent respiratory infection.20 Repetitive cough occurs whenever there is contact between the anterior and posterior walls of the trachea. Diagnosis is confirmed by radiologic imaging or bronchoscopy. The condition usually becomes symptomatic during the neonatal period and in most cases gradu-
ally improves with age. Surgical intervention is occasionally needed.

Medications
Medication-related cough is mainly caused by angiotensin-converting enzyme inhibitors (incidence 15% to 20%) and rarely by angiotensin receptor blockers. However, the use of these drugs is rare in children. The amount of time between taking the drug and the cough occurring varies widely.

Gastroesophageal Reflux
Gastric acidity in the esophagus can cause cough, either through a vagal reflex or by acid reaching to the hypopharynx and causing irritation of the upper airways (laryngopharyngeal reflex). Laryngeal inflammation may lead to persistent hoarseness of voice. However, cough and gastric reflux are independently common in young children. Contrary to adults, a causal relationship is weaker in children, particularly because cough from any cause can exacerbate reflux. A relationship may exist if cough is exacerbated after eating or when lying down. A trial of antireflux treatment may be worthwhile in selected cases. Confirmation of diagnosis may require dual pH probe testing.

Primary Ciliary Dyskinesia
Congenital ciliary dyskinesia seems to be rare but is probably underdiagnosed. Usually it is not thought of until chronic pulmonary or sinus disease becomes chronic and does not respond well to antibiotics. Estimates of its prevalence have varied widely between 1 in 2200 and 1 in 40,000. Uncoordinated ciliary movement hinders its mucoclearing function and causes chronic wet cough and predisposition to frequent infections. Light microscopic examination of nasal scraping or tracheal biopsy reveals defective ciliary movement. Electron microscopy examination shows the characteristic ultrastructural defects in cilia. Frequent nasal washings help to clear nasal and sinus secretions.

Milk-induced Pulmonary Disease (Heiner Syndrome)
Heiner syndrome is rare but probably frequently missed. It should be suspected in young children fed cow’s milk who have chronic pulmonary disease. In addition to cough, there may be wheezing, failure to thrive, and persistent or recurrent pulmonary infiltrate. It is a non-IgE–mediated hypersensitivity reaction, mostly to cow’s milk and occasionally to soy or other food proteins. The inflammatory reaction affects the alveolar capillaries. In severe cases, alveolar bleeding causes pulmonary hemosiderosis, which can be confirmed by demonstrating iron-laden macrophages in tracheal aspirate or lung biopsy. A high precipitating (or IgG enzyme-linked immunosorbent assay) antibody titer to cow’s milk protein would support the diagnosis. Cough improves within days of strict avoidance of the offending food, but clearance of the pulmonary infiltrate takes several weeks to a few months. It is usually outgrown in a few years.

LABORATORY EVALUATION
Depending on the information derived from the medical history and physical examination, certain tests or consultation with specialists may be selected to identify the underlying cause.

Radiologic Evaluation of the Lungs
Chest radiographs must be obtained for every patient suffering from chronic cough and often reveal findings that suggest certain diseases (Table 4). In addition to routine posteroanterior and lateral views, decubitus views may be needed. Comparison with previous radiographs can be valuable. A right-sided cardiac shadow indicates situs inversus and possibly Kartagener’s syndrome (bronchiectasis, recurrent sinusitis, and immotile cilia). Whereas abnormal findings might suggest a cause for cough, a normal chest radiograph does not rule out pulmonary disease. Further radiologic investigations may include high-resolution computed tomography lung.

### Table 4.
Abnormal Findings on Chest Radiographs and Their Possible Clinical Significance

<table>
<thead>
<tr>
<th>Abnormal Finding</th>
<th>Possible Clinical Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bilateral peribronchial accentuation with or without hyperinflation or focal consolidation</td>
<td>Asthma, cystic fibrosis, chronic bronchitis, ciliary dyskinesia</td>
</tr>
<tr>
<td>Asymmetry in aeration or vascular markings</td>
<td>Partial airway obstruction (foreign body, vascular compression, bronchial stenosis)</td>
</tr>
<tr>
<td>Right middle lobe infiltrate</td>
<td>Atelectasis from mucus plugging</td>
</tr>
<tr>
<td>Pleural effusion or pneumothorax</td>
<td>Parenchymal lung disease</td>
</tr>
<tr>
<td>Peribronchial accentuation with macronodularity or railroad sign</td>
<td>Bronchiectasis</td>
</tr>
<tr>
<td>Hilar adenopathy</td>
<td>Mycobacterial or fungal infection, sarcoidosis, neoplasm</td>
</tr>
<tr>
<td>Large heart or pulmonary artery</td>
<td>Heart failure, pulmonary hypertension</td>
</tr>
<tr>
<td>Shifted cardiac shadow</td>
<td>Substantial atelectasis</td>
</tr>
<tr>
<td>Right-sided heart</td>
<td>Situs inversus, ciliary dyskinesia</td>
</tr>
</tbody>
</table>

*A normal chest radiograph does not exclude pulmonary disease.*
scan or other studies that may be coordinated with the radiologist.

Areas of opacity can reflect pulmonary infiltrate or atelectasis. Bilateral peribronchial accentuation (“cuffing”) with or without hyperinflation denotes diffuse airway inflammation seen in asthma or chronic infection. Peribronchial accentuation with associated macronodularity and/or linear infiltrates emanating from the hilum points to bronchiectasis. Asymmetry in aeration or vascular markings show the possibility of partial airway obstruction, such as from a foreign body, vascular compression, or bronchial stenosis. Mediastinal widening or hilar adenopathy shows the possibility of mycobacterial or fungal infection, sarcoidosis, or tumor. Cavities with or without air-fluid level indicate cystic lesion or abscess. If foreign body aspiration is suspected, chest radiographs should be obtained during both inspiration and expiration to evaluate areas of hyperinflation distal to airway obstruction. Abnormalities of the pleura include pneumothorax, pleural effusion, and pleural thickening, all of which suggest underlying lung disease. An airbronchogram may show areas of airway obstruction by stenosis or compression.

Sinus Imaging
Radiographs of the sinuses, even just a Water’s view, are relatively inexpensive and may reveal major abnormalities in the sinus cavities. Sinus computed tomography scans are being increasingly used and can reveal more details of the nasal and sinus cavities. Abnormalities can be in the form of mucosal thickening, opacification, air-fluid level, polyps, or obstruction of the osteomeatal complex area.

Pulmonary Function Tests
Most children older than 5 or 6 years can perform spirometry, which can detect restrictive or obstructive pulmonary disease. If forced expiratory volume in 1 second (FEV₁) is low, the test should be repeated after bronchodilator (albuterol) inhalation; improvement indicates reversible bronchospasm, probably reflecting asthma. A blunted inspiratory curve of the flow-volume loop indicates extrathoracic airway obstruction.

Allergy/Immunology Evaluation
Personal or family history of atopy warrants screening for allergy by checking total serum IgE level and allergy skin testing or serum testing for common allergens. Children with a history of recurrent infections should be screened for immunodeficiency by checking serum IgG, IgA, and IgM levels and specific antibody titers to pneumococcus, diphtheria, and tetanus. For further evaluation of immunity, a referral to a specialist is recommended.

Bronchoscopy
The primary indications for bronchoscopy in children with chronic cough are suspicion of foreign body aspiration, tracheal stenosis, airway malacia, or tracheoesophageal fistula. Bronchial mucosal brushings can also be taken to check for ciliary dyskinesia.

Tuberculin Testing
Because the presentation of tuberculosis may be subtle in children, tuberculin skin testing or QuantiFERON® (Cellestis Limited, Carnegie, Victoria, Australia) blood test should be considered, even in the absence of typical night sweating and fever. Testing is necessary in children who have a history of exposure to patients with tuberculosis.

Esophageal pH Monitoring
Gastroesophageal reflux is common in normal infants and is rarely a cause of isolated chronic cough in children without significant regurgitation. It can play a significant role in children who have neuromuscular disorders that facilitate aspiration.25 Although an empiric therapeutic trial of gastroesophageal reflux disease is common in routine clinical practice, esophageal pH monitoring is recommended for appropriate confirmation.

CONCLUSION
Chronic cough in children causes significant morbidity in patients, negatively affects family dynamics, and has substantial costs, including medical investigations and medications. It can be caused by various disorders that require a thorough investigation, starting with a detailed history taking and appropriately selected tests. Treatment should be directed to the underlying cause, which may require a multidisciplinary approach, including referral to specialists in areas such as pulmonary, allergy, immunology, otolaryngology, radiology, speech therapy, and behavior modification.

REFERENCES