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# Problems in Family Practice

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## Cough: Diagnostic Considerations with Normal Chest Roentgenograms

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Cough is the second most frequent symptomatic reason given by patients visiting office-based physicians. The patient with cough and normal chest roentgenograms requires further evaluation in addition to a detailed history, careful general physical examination, meticulous otorhinolaryngology examination, and posterior-anterior and lateral chest roentgenograms. Additional studies may need to include bronchoscopy, paranasal sinus roentgenograms, pulmonary function tests (with possible inhalation challenge and exercise studies), biopsy of lung parenchyma, assessment for gastroesophageal reflux, esophogram, bronchography, echocardiography, and consideration of psychiatric factors.

In the United States during 1979, cough was the principal reason for an estimated 12,628,000 visits to office-based physicians, accounting for 2.3 percent of the visits. It ranked sixth among all principal reasons for visits but was the second most frequent symptomatic reason given by patients.<sup>1</sup>

The physiology and mechanical aspects of cough are thoroughly discussed elsewhere.<sup>2-6</sup> Briefly, cough is described as an explosive expulsion of air creating a high linear velocity airstream with a high kinetic energy available for the acceleration and displacement of an object in the airway.<sup>4</sup> There are three phases of the cough mechanism: inspiratory, compressive, and expulsive.<sup>7,8</sup> Although coughing can be initiated voluntarily, its

reflex nature is physiologically more important.

The evaluation of cough frequently consists of a look at the "throat" and a chest roentgenogram. If these are negative, there may be little additional thought or assessment. This article is a systematic presentation of the abnormalities to consider when evaluating cough in the patient with normal chest roentgenograms. The causes of cough are multiple,<sup>7-9</sup> and no attempt will be made to mention every reported or potential cause of cough. Table 1 summarizes the major considerations in the patient with cough and normal chest roentgenograms.

### Disorders of Ear, Nose, and Throat

#### *Ear-Cough (Arnold's Nerve) Reflex*

The auricular branch (Arnold's nerve) of the vagus nerve provides the sensory nerve supply for the posterior and inferior parts of the external auditory canal and the inferior part of the outer

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**Table 1. Etiology of Cough With Normal Chest Roentgenograms**

Disorders of ear, nose and throat
Ear-cough (Arnold's nerve) reflex
Postnasal drip, sinusitis, and rhinitis
Irritants
Common cold (upper respiratory tract infection)
Infections (other)
Neoplasm
Foreign body
Thyroid enlargement
Parenchymal lung disease
Diffuse infiltrative diseases
Tracheobronchial disease
Neoplasm
Asthma
Smoking and irritants
Acute and chronic bronchitis and bronchiectasis
Cystic fibrosis
Infections
Foreign body
Compression or traction of tracheobronchial structures
Cardiovascular disease
Early congestive heart failure
Early mitral valve obstruction
Esophageal disease
Aspiration (diverticula, incompetent lower esophageal sphincter, achalasia)
Neuropsychiatric disease
Psychogenic cough (cough tic, habit cough, "honking")
Mouth breathing
Gilles de la Tourette's syndrome

surface of the tympanic membrane.<sup>10</sup> Lillie and Thornell<sup>11</sup> may have been the first to describe the cough associated with touching parts of the tympanic membrane and external auditory canal supplied by Arnold's nerve. They also noted that cough could be caused by loose scales, cerumen, or foreign bodies in the external auditory canal of patients with hyperactive Arnold's nerve reflex.

In 1963 two children with a periodic, spasmodic, and primarily nocturnal cough were described.<sup>12</sup> Although no local pathology was found, the reflex was produced by introducing the ear speculum into the auditory canal. Three other patients were subsequently relieved of their chronic

cough when a hair was removed off the tympanic membrane.<sup>13</sup> In evaluating cough, carefully examine the external auditory canal and tympanic membrane.

### *Postnasal Drip, Sinusitis, and Rhinitis*

The role of postnasal drip as a cause of cough is fairly complex and has generated considerable controversy. The term probably refers to a number of entities including allergic rhinitis, sinusitis, vasomotor rhinitis, and either an excess of normal nasal airway secretions or secretions with abnormal viscoelasticity.<sup>14</sup> Postnasal drip has been diagnosed when patients experience a need to frequently clear their throats, sense something dripping down into their throats, or when examination demonstrates secretions and/or a "cobblestone" appearance to the mucosa.<sup>15</sup> Many otolaryngologists are unable even to define postnasal drip.<sup>16</sup> Unfortunately, the term *postnasal drip* can mean almost anything to a patient.

Wynder and co-workers<sup>17</sup> noted that 37 percent of 104 male Seventh-Day Adventists (nonsmokers) complained of cough when there was a positive history of sinusitis or postnasal drip. However, only 13 percent of 135 men complained of cough when there was no history of sinusitis or postnasal drip. In 1977 Irwin and associates<sup>8</sup> stated that chronic postnasal drip was the most common cause of a chronic persistent cough in nonsmokers. This statement generated considerable discourse, both for and against it.<sup>14,16</sup> Irwin and co-workers<sup>15</sup> later studied 49 patients with chronic persistent cough of at least three weeks' duration and found that chronic postnasal drip from rhinitis (allergic or perennial nonallergic) or sinusitis was the cause of cough in 29 percent of the patients. There seems to be some agreement that a purulent sinusitis or rhinorrhea (allergic or vasomotor) can initiate a chronic cough.<sup>14,16</sup>

A similar controversy occurred in England when an editorial<sup>18</sup> related night cough to postnasal drip in children. A rebuttal<sup>19</sup> quickly appeared citing lack of scientific evidence, and additional discussion followed.<sup>20,21</sup> The question of allergy and cough (allergic cough syndrome) is mentioned for completeness.<sup>22-24</sup> The cough is usually a dry hacking cough, and the majority of the patients

have a clear postnasal discharge. In summary, perhaps some patients have secretions originating from a source above the larynx, and these secretions, in their caudal descent, can produce cough. The evaluation of cough should include roentgenograms for paranasal sinus disease and a meticulous examination, possibly by an otorhinolaryngologist.

### *Irritants*

Sufficient environmental and occupational exposure to various mineral dusts, organic dusts, chemical vapors, and gases can produce mucosal irritation and cough. A detailed history can be helpful.<sup>25</sup>

### *Common Cold*

The most frequent entity causing a transient cough in adults and children is the common cold.<sup>8</sup> The illness is self-limiting, and a persistent cough should be evaluated for another cause.

### **Parenchymal Lung Disease**

Cough may be a significant manifestation of diffuse infiltrative lung disease. Renzi and Lopez-Majano<sup>26</sup> described two patients with abnormal pulmonary function tests, cough, normal chest roentgenograms, and a diagnosis of interstitial pulmonary fibrosis confirmed by open lung biopsy. In patients with various histologically proven chronic diffuse infiltrative lung disease, 9.6 to 15.8 percent of the patients can present with a normal pre-biopsy chest roentgenogram.<sup>27,28</sup> In patients with proven cryptogenic fibrosing alveolitis, a normal chest roentgenogram was noted in 2 percent of the patients.<sup>29</sup> Approximately 5 percent to 6 percent of patients with histologically proven sarcoidosis have a normal chest roentgenogram.<sup>27,30</sup> Disordered pulmonary function tests can indicate the presence of such diseases in patients with cough and normal chest roentgenograms.

### **Tracheobronchial Disease**

#### *Neoplasm*

Cough is one of the common symptoms in patients with tracheal tumors.<sup>31</sup> Cough frequently accompanies an endobronchial neoplasm, but the chest roentgenogram is rarely normal. Cough occurs in the majority of patients with bronchial adenoma, and the chest roentgenogram may be normal in 4.2 percent to 6.1 percent of the patients.<sup>32,33</sup> Endobronchial metastases rarely present with a normal chest roentgenogram, and the primary tumor site is usually clinically apparent.<sup>34</sup>

The frequency of cough as the initial presentation of lung cancer varies between 29 percent and 87 percent.<sup>35</sup> Cough may be produced by a small tumor acting as a foreign body or by ulceration of the bronchial mucosa. Although unusual, symptoms can be caused by lung cancer that is not apparent on the chest roentgenogram.<sup>36,37</sup> In the patient with an occult lung cancer, cough may be due to the cancer or the associated chronic obstructive lung disease. In the cigarette smoker with a persistent cough and normal chest roentgenograms, bronchoscopy and cytological studies are appropriate.

#### *Asthma*

Wheezing has long been regarded as the primary symptom of asthma. However, in about 25 percent of patients with cough and a normal chest roentgenogram, asthma may be the cause of cough.<sup>15</sup> In 1975 McFadden<sup>38</sup> described seven patients (nonsmokers) with asthma whose primary complaint was cough. They concluded that the episodes of cough could represent variant aspects of asthmatic attacks. Two subsequent studies have reported seven patients with chronic cough but no history of wheezing or dyspnea.<sup>15,39</sup> These patients had normal baseline spirometry, but methacholine inhalation challenge demonstrated hyperreactive airways. They were considered to have a variant form of asthma with cough as the only presenting symptom. In children and teenagers, chronic cough can be a manifestation of hyperreactive airways and requires pulmonary function testing after exercise for diagnosis.<sup>40</sup>

The frequent association of bronchial asthma and paranasal sinus disease has been observed for

many years, and almost all the patients complained of cough.<sup>41-43</sup> The cough may be the only symptom of asthma or hyperreactive airways related to sinusitis. Pulmonary function tests, possibly including a methacholine inhalation challenge or exercise study, should be considered in the evaluation of cough.

### *Smoking and Irritants*

Persistent cough may occur in 56 percent to 67 percent of male cigarette smokers. The risk of persistent cough increases with the rate of cigarette use.<sup>17</sup> Lebowitz and Burrows<sup>44</sup> noted a mere 3.9 percent to 6.8 percent prevalence of cough in patients who had never smoked. The prevalence of cough in those smoking up to 20 cigarettes daily was 21 percent to 28.4 percent, and this increased to 38.5 percent to 64.7 percent in those smoking more than 20 cigarettes daily. There seemed to be no significant difference between men and women regarding cough and cigarette smoking.

Cessation of cigarette smoking will produce a significant reduction in cough. Among 224 ex-cigarette smokers, the persistent cough stopped in 77 percent and improved in 17 percent. The cough stopped within four weeks in 54 percent of those individuals in whom the cough totally ceased.<sup>45</sup> Although in some individuals the benefits of ceasing cigarette smoking are quickly apparent, in others it may take three to four years before the prevalence of chronic cough decreases to the level found in nonsmokers.<sup>46,47</sup> An individual who denies smoking tobacco cigarettes may be smoking marijuana or hashish. This smoke can be quite harsh with resultant bronchitis and cough.<sup>48,49</sup>

### *Acute and Chronic Bronchitis and Bronchiectasis*

Acute bronchitis can occur during a common cold or other influenza-like illnesses. The main symptom is cough associated with some or all of the symptoms of an upper respiratory tract infection. The illness is usually mild and self-limiting. Another cause must be considered if the cough persists beyond several weeks.

Chronic bronchitis, with cough an integral part of the commonly accepted definition,<sup>50</sup> is a recurrent productive cough. Some patients, however, may not expectorate and indicate the cough is not productive. In patients clinically judged to have chronic bronchitis, 41 percent have no demonstrable abnormalities on the chest roentgenogram.<sup>51</sup> A bronchogram, unlike a plain chest roentgenogram, usually demonstrates a considerable number of abnormalities in chronic bronchitis.<sup>52,53</sup>

Bronchiectasis, when symptomatic, is usually associated with cough and sputum production. The study of Gudberg<sup>54</sup> demonstrated that 7.1 percent of 112 patients with bronchiectasis had normal chest roentgenograms. A bronchogram is necessary to demonstrate the early bronchiectasis that can cause an otherwise puzzling chronic cough.

### *Cystic Fibrosis*

Cystic fibrosis is now the most common cause of chronic obstructive pulmonary disease in the first three decades of life in the United States.<sup>55</sup> Many patients with cystic fibrosis are reaching adulthood and even graduating from college.<sup>55,56</sup> Cough is essentially a universal symptom in these patients, and a history of frequent lower respiratory tract infections is often elicited. Approximately 2 percent of adults with cystic fibrosis may present with a normal chest roentgenogram, and many more may have subtle findings of increased interstitial markings.<sup>55</sup> The quantitative pilocarpine iontophoretic test is the sweat test method of choice to diagnose cystic fibrosis.<sup>57</sup> In the young adult nonsmoker with persistent cough, cystic fibrosis should be considered.

### *Infections*

With the exception of acute viral or bacterial tracheobronchitis, most infections of the respiratory system that result in cough are almost always apparent on the chest roentgenogram. Tuberculosis of the upper respiratory tract and tracheobronchial tree is almost always associated with abnormalities on the chest roentgenogram.<sup>58-60</sup> However, a normal chest roentgenogram can occur with endo-

bronchial tuberculosis.<sup>60-63</sup> Very unusual causes of cough with a normal chest roentgenogram, such as a bronchial infection with nematode worms, can occur.<sup>64</sup>

### Foreign Bodies

A large variety of unsuspected foreign bodies in the upper and lower airways should be considered as a cause of cough, with or without wheezing, especially in children. The chest roentgenogram may be normal in 20 to 38 percent of the patients.<sup>65,66</sup> The majority of foreign bodies tend to be organic, such as peanuts, seeds, and bones, and may not be radiopaque.<sup>65,66</sup> The history is not always reliable, and a time lag of greater than 30 days may occur between the event and presentation to a medical facility.<sup>65</sup> A high index of suspicion and careful bronchoscopy are appropriate.

### Cardiovascular Disease

Nonproductive cough can be an early and important symptom of cardiovascular disease. The cough can occur intermittently with normal chest roentgenograms.<sup>67</sup> The cough is probably related to interstitial congestion insufficient to appreciate on the chest roentgenogram. Most cardiovascular causes of cough, such as an aneurysm, large left atrium, congestive heart failure, and pulmonary venous distention, are apparent on chest roentgenograms.

### Esophageal Disease

Various respiratory symptoms, including cough, have been attributed to the reflux of gastric acid into the esophagus and the suspected subsequent aspiration into the tracheobronchial tree.<sup>15,68,69</sup> Conclusive proof that microaspiration does take place in patients with cough and

gastroesophageal reflux is lacking.<sup>70,71</sup> Some evidence is accumulating that gastroesophageal reflux and possibly the tracheobronchial aspiration of gastric contents may act as one of many "trigger factors" in reversible airway obstruction.<sup>72-74</sup>

The association of gastroesophageal reflux and aspiration with a normal chest roentgenogram and cough is not well defined.<sup>75</sup> With cough and a normal chest roentgenogram, gastroesophageal reflux may be the cause of the cough in about 10 percent of patients.<sup>15</sup> The cough due to gastroesophageal reflux and the aspiration of gastric acid is most likely secondary to laryngeal irritation and is often quite severe. The cough tends to be nocturnal, unproductive, and some inflammation of the cords may be present.<sup>68</sup> Barium studies are not adequate to diagnose gastroesophageal reflux.<sup>76</sup> Gastroesophageal scintiscanning is a reasonable test for gastroesophageal reflux.<sup>77</sup> The test with the highest degree of accuracy, but not necessarily the most practical, is the nocturnal or 24-hour monitoring of the esophageal intraluminal pH.<sup>78,79</sup> The scintigraphic monitoring for the pulmonary aspiration of gastric contents is probably not worthwhile.<sup>70,71,80</sup>

Gastroesophageal reflux and laryngeal and/or tracheobronchial irritation by gastric acid should be considered as a cause of cough, particularly in the nonsmoker with a normal chest roentgenogram. Most other forms of esophageal disease, such as diverticula and achalasia, are associated with abnormalities on the chest roentgenogram.<sup>81,82</sup>

### Neuropsychiatric Disease

Psychogenic cough (cough tic), usually in children or adolescents, can be a very perplexing and troublesome symptom for the patient, the physician, and the patient's family. The cough is nonproductive, brassy, and repetitive, having an explosive bark-like or "honking" quality.<sup>83</sup> The cough is unaccompanied by systemic signs or symptoms of chronic disease. A constant feature is the presence of cough during the waking hours. An excellent clue to a psychogenic cough is the absence of cough during sleep. These patients do not respond to antibiotics, expectorants, or cough suppressants.<sup>84-87</sup>

Adults can also manifest a psychogenic cough that results from the conversion of anguish or emotional stress. The cough could become a symbolic attempt to handle anger, tension, or frustration or to escape from a problem.<sup>88</sup> Anxiety with mouth breathing can result in excessive dryness of the pharyngeal tissues and initiate an irritative stimulus for cough.<sup>16</sup>

Gilles de la Tourette's syndrome is a rare condition characterized by tic-like movements, compulsive behavior, and involuntary vocalizations. The syndrome first appears during childhood, and the voluntary vocalizations include cough (20 percent), throat clearing, barking, hissing, and many other unusual sounds. The diagnosis is apparent upon observation of the patients.<sup>89-91</sup>

### Summary of Diagnostic Investigations

A variety of diagnostic techniques may be necessary in the patient with cough and a normal chest roentgenogram. Initially, a meticulous history and physical examination may direct the physician to a specific area. A careful examination of the ears, larynx, and pharynx may demonstrate unsuspected irritation, infection, neoplasm, or other abnormalities. Paranasal sinus roentgenograms may demonstrate unsuspected sinusitis. Pulmonary function tests may demonstrate a restrictive pattern consistent with an unsuspected interstitial lung disease. A methacholine challenge, with prechallenge and postchallenge spirometry, may be necessary to diagnose cough variant asthma.

Bronchoscopy and cytologic studies when appropriate are indicated in a patient with a cough that persists beyond several weeks or in a cigarette smoker with a new or changing cough. A bronchogram may be required for the definite diagnosis of cryptic bronchiectasis or chronic bronchitis. A sweat test and a high index of suspicion will diagnose some patients with cough as having cystic fibrosis. Gastroesophageal scintiscanning and monitoring of esophageal intraluminal pH may demonstrate gastroesophageal reflux as a cause of an otherwise puzzling cough. In some patients an unsuspected habit or emotional cause of cough may require psychiatric evaluation.

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