Man's most common symptom is cough. Because of its frequency, cough is often taken for granted by the patient and is overlooked by the physician. Cough is defined as a sudden violent expulsion of air after deep inspiration and closure of the glottis. The results of a cough may be either harmful or helpful to the patient. The cause of a cough must be known to the physician if he is to appraise the results. To this end a careful and detailed history must be obtained.

The diagnosis of bronchiectasis is apparent at once when the following history is elicited: Cough, productive of one to three teacupsful of sputum per 24 hours which may or may not be blood streaked, and is not excessively offensive in odor. This cough has persisted over a long period of time and usually originates after an infection such as influenza, pneumonia, or measles. The patient is not acutely ill and has lost little or no weight.

Again the diagnosis is easily and quickly made by a history of persistent coughing with loss of weight, night sweats, a history of pleurisy and contact with active pulmonary tuberculosis. The patient may have had blood streaked sputum, hemoptyysis, chest pains, afternoon elevation of temperature, loss of energy and abnormal fatigue.

All diagnoses are not so easily determined, and an intimate knowledge of the co-existing physiological conditions relating to the causes must be obtained. For example the following differences between harmful and helpful coughing must be well understood:

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(1) Harmful coughing is produced by: 1-3

(A) Stimulation of the cough reflex by extra-pulmonary irritation due to:
(a) Drainage from the paranasal sinuses
(b) An elongated uvula
(c) Pressure on the trachea or bronchi by mediastinal inflammation, tumors, or dilated blood vessels

(B) Non-inflammatory lesions of the bronchial tree such as benign or malignant tumors

(C) Inflammatory processes of the bronchi or the lung parenchyma without the formation of exudate, but with constant irritation of the cough centers; as, in the dry cough of early acute bronchitis

(D) Mucopurulent or mucoid secretions resulting from inflammation of the bronchial tree that are too tenacious to be removed by cough, as in the paroxysmal stage of whooping cough

(E) Transudation in the alveoli during heart failure

(F) Obstruction of the bronchial tree due to pathological changes which cause retention of the secretions and exudates distal to the obstruction

(G) Atelectasis, because the definition of cough cannot be fulfilled

(H) Emphysema as result of:
   (a) Weakening and destruction of the elastic structures
   (b) Reduction of the intrapleural sub-atmospheric pressure
   (c) Abnormally low position of the diaphragm

(I) Fatigue and exhaustion of the expiratory muscles; as in fibrotic tuberculosis and pulmonary fibrosis

(J) Psychogenic cough such as that produced by the exhibitionist

(K) Allergies (Approximately 1,000,000 people in the United States have asthma)

(2) An unsuccessful or harmful cough is found especially in pulmonary tuberculosis and may result also in:

(A) Pulmonary hemorrhage

(B) Laryngitis

(C) Spontaneous pneumothorax

(D) Vomiting

(E) Loss of appetite

(F) Exhaustion

(G) Headache

(H) Insomnia

(I) Elevated temperature

(J) Marked dyspnea

(K) Cyanosis

(L) Thoracic pain

(M) Fracture of ribs

(N) Mediastinal emphysema

(O) Subcutaneous emphysema

(P) Subconjunctival hemorrhage

(Q) Urinary incontinence

(R) Myocardial failure

In contrast a helpful cough has as its purpose the removal of: abnormal mucous, inflammatory products, foreign bodies, products resulting from circulatory congestion and all irritating sensations in the respiratory tree. To be successful, a cough must produce effective drainage of the lung during an inflammatory disease without undue stress on any of the tissues of the body.
The need for successful management of coughing is emphasized by the possibility of contagion in infectious diseases. It is estimated that an average of two and one-half colds occur for every man, woman and child in the United States each year. A person talking in a normal conversational tone sprays out sputum for a distance of eight feet. A cough carries sputum 12 to 15 feet, and a sneeze may propel particles as much as 20 feet. An analysis of airborne transmissions of disease has shown that tubercle bacilli may travel by droplets no larger than 0.2 mm. which quickly clear from the air by gravity. Droplet nuclei, less than 0.1 mm., which quickly evaporate, continue to float and are a dangerous cause of infection.

"The cough center is located in the medulla near the sensory portion of the vagus nerve and also near the vomiting center. The cough center is subject to both peripheral and central stimuli and is depressed by drugs such as the alkaloids of opium, alcohol and anaesthetic agents. Coughing is provoked by the stimulation of the sensory endings of the glossopharyngeal and vagus nerves."1-3 Eight groups of branches of the vagus nerve are associated with cough. They are described as: Arnold's branch to the ear which is stimulated by wax, eczema, etc., causing a cough; the pharyngeal branch; the superior laryngeal branch sensory to the base of the tongue and larynx and is frequently a cause of coughing. Among this group is also found the inferior laryngeal branch (motor), which may produce an inefficient cough; and cardiac branches, which are indirect causes through circulatory failure. The last three in this group are listed as: the pulmonary branches which are concerned in the cough of gross pulmonary or pleural diseases; the esophageal and precordial branches; and the gastric branches which occasionally cause coughing due to dyspepsia.

The irritants to the surfaces enervated by the distribution of these nerves are: foreign bodies as dust, food, tobacco, smoke, etc.; excess natural secretions; pressure and inflammation; and acute or chronic simple debility or increased irritability. The secretory function of the glands of the bronchial mucosa is increased by stimulation of these vagal nerve endings.

Rhythmic relaxation and contraction of smooth muscles in the wall of the bronchioles is a normal process. Occlusion of the smaller branches of the bronchial tree is caused by spasm of these muscles. This may result from allergies and irritants; as, gases, fumes, and foreign bodies, and may lead to dyspnea, anoxemia, atelectasis, and increased cough.

Bronchi and bronchioles have a peristaltic motion directed from the smaller structures toward the larger structures. It is inde-
ependent of respiratory movement. Drugs of the parasympathomimetic group, which cause bronchospasm, also decrease or abolish bronchial peristalsis. Inhalation of carbon dioxide and oxygen in the proper mixture increases this peristaltic motion.1-3

Cilia in larger and smaller bronchi normally drive inert material toward the larynx. Destruction of the sensory nerve endings of the vagus (by any pathological process) destroys the ciliary function. Absence of the cilia; as, in bronchiectasis, deprives the lung of this much needed help. Alkaline solutions stimulate ciliary motion. The normal motion of bronchial secretions toward the larynx may be unfavorably influenced by drugs that change their consistency or amount such as morphine which suppresses normal bronchial secretions.

The pharmacology of cough control may be divided into: local applications; medication transported through the blood stream to the mucous membrane of the respiratory passages; and medication which stimulates the central nervous system. Local applications may be soothing to the mucous membrane as lozenges or hyperemic when produced by inhalations of vapors of volatile oils such as eucalyptol and creosote. A third group of local medications include aerosols of a bacteriastatic nature combined with mucous membrane stricking agents. The most common blood borne drugs used for aiding the cough mechanism are ammonium chloride, potassium iodide, and creosote. Direct action on the central nervous system is demonstrated by carbon dioxide inhalations. Paregoric acts indirectly by irritating the vagus nerve endings in the gastric mucosa.

Now that the cause of cough has been determined and its physiology is understood, the treatment is to be considered. When tumor, foreign body, elongated uvula, dilated blood vessels, and atelectasis are found to be the cause, appropriate surgery is most often indicated. Surgery is needed often in infections; such as, bronchiectasis, lung abscess, empyema, and other pulmonary complications. Deep x-ray therapy may or may not be indicated, alone or in conjunction with surgery in the above conditions. The presence of infection, the type of infection, the location, extent and character of the lesion will indicate the treatment. It goes without saying that the cure of the disease stops the cough. The treatment of the various diseases of which cough is a symptom is beyond the scope of this paper.

The amount of secretion expectorated is not a true index because some of the secretion is resorbed, especially where it is thick or scanty. Resorption is done by a process of digestion or dilution and liquification through the admixture of the secretions of the glands of the bronchial mucosa and the alveoli.6 The re-
sorptive capacity of the lungs can be effectively increased by oral administration of ammonium chloride, potassium iodide, fluid extract of senega, fluid extract of ipecac, emetine hydrochloride, and by inhalation of oxygen under positive pressure.

When indicated, drug therapy should be applied judiciously. The Manual of Pharmacology, 1948, seventh edition by Sollmann and the Pharmacological Basis and Therapeutics, 1941, by Goodman and Gilman, enumerate and classify expectorants under the heading of anodyne, sedative, and stimulative expectorants.

(1) Anodyne expectorants depress the cough reflex by central action.

(A) Morphine alkaloids depress the irritative reflex and decrease the amount of bronchial secretions. They are used when the cough is dry and hacking, but are contraindicated when excessive mucous is present. Codine, tincture of opium, and pantopon are the most commonly used. Heroin should be avoided, because of its habit forming tendency.

(B) Piperidine (sedulon) depresses the medullary centers, especially the cough center.

(2) Sedative expectorants tend to alleviate the inflammatory process by promoting the secretion of protective mucous, thus decreasing the frequency of paroxysms of cough. They are divided into three groups, each acting in a different way:

(A) Saline expectorants, although their exact mode of action is not known, are believed to act reflexly, stimulating bronchial secretions through local gastric irritation: They are: ammonium chloride, for "tight" coughs; ammonium carbonate, for liquifying thick, purulent mucous; iodides, for increasing bronchial secretions by rendering them less viscid. They are used preferably in chronic cases to "loosen" the cough. Citrates and acetates of sodium are used as expectorant drugs primarily on an empirical basis.

(B) Nauseant expectorants increase the secretion and lessen the viscosity of bronchial mucous. In addition to their expectorant effect, they have a nauseant and emetic action which is chiefly central in origin. Such drugs are ipecac, emetine, tartar emetic, apomorphine, salts of ammonium (especially the chlorides and carbonates), and drugs acting through the saponins, which include squill, senega, and grindelia.

(C) Demulcent expectorants diminish the tendency to cough by a local soothing effect on the inflamed mucosa of the
pharynx. Such drugs are: syrup of acacia, licorice, glycerin, cane sugar, "cough drops," and hot drinks.

(3) Stimulant expectorants are mildly irritating in nature, but most of them will diminish bronchial secretion. Among these drugs are: creosotes (calcium creosotate and creosote carbonate), gualacol (potassium orthoguaicol-sulfonate in a syrup), terpin hydrate, balsams of Tolu and Peru, tar, and terpin. To this may be added the drugs described by Young:

(A) Antispasmodic drugs (broncho-dilator or antispasmodic), which include atropine, belladonna, stramonium, lobelia, hyoscyamus, epinephrine, ephedrine, nicotine, and papaverine.

(B) Other drugs that may be used to promote expectoration are: strychnine, coramine, and cardiazol. Other agents such as: liniments, poultices, heat, diathermy, and oxygen also may be employed.

The role of respiratory motion in the removal of inflammatory products from the bronchi is important. This rhythmically repeated motion tends mechanically to remove secretions.

Certain gases such as carbon dioxide and oxygen aid in increasing respiratory motion and, in turn, the removal of inflammatory products from the bronchi. Shallow breathing is harmful and is usually found in debilitated patients, or as an effect of general anesthesia, or in depression of the respiratory center by narcotics, or in anoxemia which may excite more vigorous breathing only to be followed by greater depression of respiration.

Secretions in the smaller bronchi do not produce effective cough. They are only effective in the larger bronchi; therefore, a pathological process localized in the bronchioles, such as, in bronchiolitis, may cause respiratory distress, anoxemia, and cyanosis. In the absence of an effective cough, therapeutic intervention is necessary to drain the small bronchi, but such therapy must not increase the accumulation of exudate.

Short inhalations of 5 to 10 per cent carbon dioxide with oxygen are found to give the best results. There is an increase in the rate of respiration and in the volume of air in the lungs; the ventricular output of the heart is augmented; the systolic and diastolic blood pressures are raised; pulse rate is accelerated; and pulse pressure is elevated.

Carbon dioxide and oxygen are contraindicated "when there has been recent pulmonary hemorrhage; when the patient has marked emphysema; or wide-spread pulmonary fibrosis without atelectasis, bronchiectasis, or mucopurulent retention in the air pass-
ages. Acute plastic pleurisy, pleurisy with effusion, and hypertension, as well as cough arising from causes outside the lungs also are contraindications to the use of these gases.¹⁻³

The use of antibiotics in aerosol for the treatment of pulmonary infection has been discussed extensively in the literature⁹ and needs no repetition here, except to recommend that one-half cc. of epinephrine be added to each portion of aerosol (certain conditions excepted), and that large doses of the antibiotic be given intramuscularly in a vehicle that prolongs the maintenance of high levels of concentration of the drug in the blood. One aerosol treatment and one intramuscular injection per day usually is sufficient. It must be remembered that some patients respond only to double or even triple the usual dose of each intramuscular injection.

Effective concentrations of drugs given by aerosol can be demonstrated by the following¹⁰ examples. The volume of air inspired by the lungs is approximately doubled by 1 per cent atropine (from 450 to 1000 cc.), by 5 per cent sodium nitrate (from 500 to 600 cc.), and by 1 per cent procaine hydrochloride (from 650 to 1000 cc.).

Instillations of oil, iodinized oil, and oil combined with the sulfonamides or the antibiotics may be used effectively in a small number of instances. It has been argued that instillation of oil renders the cilia useless, and therefore, should not be used. However, from a practical standpoint, in such diseases as bronchiectasis, temporary improvement in the cough and other symptoms is seen occasionally. The patient should be told that this method is a temporary measure and that the underlying disease will have to be cured by other means, for unquestionably the patient is greatly impressed by its use. Oil instillations should be followed always by adequate and supervised postural drainage.

Attention is called especially to the fact that a high percentage of patients with chronic coughs have some form of allergy. Many people are sensitive to iodine. All patients should be watched closely while this drug is being used.

Allergic cough was described by Prigal¹¹ as having definite characteristics. It is a loud, barking cough, paroxysmal in nature, and is relatively non-productive. It may last from a few minutes to hours or days. It defies analysis by the usual methods of examination, in that it presents negative radiographic findings in the chest, negative bacteriological findings in the sputum, and negative physical findings in the chest. The patient looks and feels well, but usually complains of an itchy, scratchy, or rubbing sensation deep in the throat.

The allergic nature of this cough is verified by certain phenomena common to all allergic diseases, such as: a history of
allergic manifestations in other members of the family, or by a history of past and/or concomitant allergic conditions, such as: urticaria, eczema, gastro-intestinal allergy, migraine, or similar conditions. There may be sensitivity to allergens, demonstrable by skin test, or by the therapeutic response to epinephrine and related drugs. Some of such patients have seasonal or perennial cough which is relieved by the removal of the causative agent, and some obtain reduction of sensitivity by hyposensitization with the allergen concerned, particularly if it is an inhalant. Antihistaminic drugs are to be used with discretion even in the allergic patient, because of the short duration of the beneficial results and because of possible reactions.

The indications for the use of x-ray therapy and the method of its administration has not changed for many years. It is usually reserved for those cases which fail to respond to other forms of treatment. Radiation to chronic infections in the sinuses and throat aid in stopping the postnasal drainage that produces a large number of chronic coughs. Mild radiation over the lungs decreases the secretion of the glands lining the bronchi and destroys a certain amount of lymphoid tissue. It is theorized that this breaking down of the lymphoid tissue liberates a protein-like substance. Relief from symptoms is slow in this type of treatment and the delay should be explained to the patient.

Personal care is important in the management of chronic coughs. Patients should be instructed to keep outside windows in sleeping quarters closed in damp or cool weather. They should avoid changes in temperature as much as possible. They should wear warm sleeping apparel at nights and warm clothing during the day. They should avoid drafts both at night and in the daytime, and should avoid dust or other irritating inhalants at all times. Exercise may well be restricted and smoking should be discontinued. If possible they should avoid others who have respiratory infections. Regular habits at all times, and a maximum amount of mental and physical rest are helpful. Every effort should be made to go into the patient's home care problems. Most patients are ignorant of hygienic care and must be taught in detail.

**SUMMARY**

A review of the literature has been made. These conditions have been taken up and discussed under the following headings: History, pathology, physiology, pharmacology, contagious factors, differentiation of helpful and harmful coughs. Treatment has been discussed under the heading of anodyne sedative and stimulating expectorants with a discussion of newer drugs and gases and different methods of administration. The nature and relief of allergic
cough has been discussed. X-ray therapy and its application has been discussed. The author deems the understanding of the physiology and pathology of cough more important than the other factors for the simple reason that a thorough understanding will bring about a correct diagnosis and offer greater opportunity to alleviate this symptom.

RESUMEN

Se ha hecho una revisión de la literatura. Se han tratado y discutido estas condiciones bajo los siguientes aspectos: Historia, patología, fisiología, farmacología, factores de contagio, distinción entre las toses benéficas y las dañinas. Se ha discutido su tratamiento bajo el título de sedante anodino y expectorantes estimulantes, discutiéndose las nuevas drogas y gases y los distintos métodos de administrarlos. Se ha discutido la naturaleza de la tos alérgica y su alivio. Se ha discutido la terapia con rayos X y su aplicación. El autor considera de mayor importancia la comprensión de la fisiología y patología de la tos, que los otros factores, por la sencilla razón que su comprensión más perfecta dará lugar al diagnóstico correcto, y ofrecerá mejor oportunidad para aliviar este síntoma.

RESUME

L’auteur fait la revue de la littérature sur le problème de la toux. Les différents facteurs suivants ont été envisagés: historique, anatomie pathologique, physiologie, pharmacologie, facteurs épidémiques, différenciation des toses utiles et des toses nuisibles. L’auteur envisage le traitement sous l’angle des sédatifs sans danger, et des stimulants de l’expectoration. Il met en discussion les médications les plus nouvelles et les méthodes d’inhalation gazeuse, ainsi que leurs modes d’administration. Il étudie la nature et la façon de soulager la toux d’origine allergique. Il décrit les traitements par radiothérapie, et ses indications. L’auteur estime que les facteurs les plus importants à bien comprendre sont la physiologie et les causes anatomiques de la toux. C’est grâce à leur étude que pourra être établi un diagnostic correct et une possibilité de soulager le symptôme.

REFERENCES