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BRONCHIECTASIS

SENIOR THESIS

1933

John J. McCarthy
B R O N C H I E C T A S I S

DEFINITION

The word "bronchiectasis" comes from the Greek (30) and means bronchial dilatation and sacculation of bronchi and bronchioles with infection, associated with chronic cough and purulent sputum. Some authorities (5) state that bronchiectasis consists of bronchial dilatations associated with bronchial and peribronchial changes which may produce the thickening of walls; others that it is a diseased state of the bronchi in which they become dilated and distorted, producing dilatations and enlargements which may be single or multiple, local or general.

The bronchial dilatations may be of congenital origin, or acquired. The congenital type gives rise to characteristic symptoms only following a persistent infection. The acquired type has a varied pathological anatomy, pathogenesis, and etiology. The condition is essentially one of bronchial disease in which dilatation is only one of the pathological changes.

HISTORY

In ancient times most chest conditions were known as phthisis (44). There were many kinds of phthisis; in fact as late as the time of the Sauvages, 1706 to 1767, this disease was classified into twenty different kinds. Morton reduced the number to sixteen, Portal to fourteen, and Baylc, living from 1774 to 1816, reduced the number to six. Baylc and Laennec were close friends, but Baylc died of
tuberculosis the year Laennec presented the stethoscope (44).
With this new device for examination, with a splendid training
in anatomy and pathology, and with a wide experience at the post
mortem table, Laennec changed the interpretation of physical
signs and symptoms of the chest. He was able to take out of phthisis
much that it formerly contained. He worked out carefully such dis-
eesases as gangrene, pneumonias, edema, empyema, and atrophy of lungs.
He took melanosis from the category of pulmonary phthisis, consider-
ing such cases as due to anthracosis, or cancer. He also took can-
cerous phthisis from pulmonary phthisis. Of course, many of his
diagnoses were not made before death, but based on autopsy findings.

Cayol in 1808 first directed Laennec’s attention to dilatation of the bronchi, and Laennec in 1819 described the diseased state of the bronchi known as bronchiectasis (5). In the century which has passed since Laennec’s death, we have had many developments which have facilitated differential diagnosis in the living body.

Corrigan (48) in 1838 believed that cirrhosis of the lung was the cause of bronchiectasis. A few years later Charcot pointed out that bronchiectasis was a sequel of bronchopneumonia which destroyed the elastic and muscular coats of the bronchi.

In 1882, Koch (44) discovered the tubercle bacillus. Other aids in diagnosis such as the patient’s history, physical examination, tuberculin test, X-ray, bronchoscope, microscope, and iodized oils are doing much in the way of differential diagnosis in the chest.
Jackson (3) in 1918 described the technique of lung mapping by dry bismuth insufflation, and Lynch in 1930 injected through the bronchoscope a bismuth mixture in pure oil for the localization of an abscess cavity. Sicard and Forrestier (3) were the first in 1922 to utilize Lipiodol for localization of tumors in spinal canal. Sergent and Cottenlot in 1923 first injected Lipiodol into trachea in study of bronchiectasis.

**INCIDENCE**

The general impression which seems to exist is that bronchiectasis is a relatively rare disease. Surely, there is very little space devoted to the disease in the standard textbooks, and very little time devoted to its study in medical schools. Moreover, in this review of the subject, we find wide variations in the opinions of different authors as to the incidence of bronchiectasis.

Hedblom states (30) that bronchiectasis ranks in frequency next to pulmonary tuberculosis among the chronic pulmonary infections. It occurs in two to four per cent of necropsies in general hospitals (Osler). Other authors state the average frequency at autopsies to be from one to four per cent.

Lebert & Lord (30) report an average incidence of one per thousand patients, but clinical diagnosis has improved since that time, hence this number may be larger.

Hartung (26) also claims that bronchiectasis ranks second to pulmonary tuberculosis among the chronic pulmonary infections.

Ochsner (46) states that from his experience, bronchiectasis is the most frequently encountered chronic pulmonary infection,
occurring even more frequently than pulmonary tuberculosis. He believes, that since introduction of iodized oil, more cases may be found clinically, then there are cases which show marked anatomic change at autopsy. Ochsner believes there are a large number of cases of bronchiectasis, diagnosed and treated as tuberculosis, merely to give patient the "benefit of the doubt". Hamilton (25) states that twenty-five to fifty per cent of all inmates of tuberculosis sanatoria are nontuberculous.

In reply to such claims that many patients with bronchiectasis are harbored in tuberculosis sanatoria, Burke (14) states that this is no longer true, improved diagnostic methods, and rigid diagnostic standards. However, fifty cents of non-tuberculous patients found in Burke's review were cases of bronchiectasis.

From Fitzimmon's U. S. General Hospital (36) during the past five years there have been 133 patients discharged with diagnosis of bronchiectasis, while 60 cases were treated over a period of one and one-half years. Marvin (36) sees the importance of early diagnosis and treatment of this disease.

Jex Blake (48) reported the incidence of bronchiectasis in hospital cases as one and nine-tenths per cent. He thought that with better diagnosis it would be five per cent. Lemon (33) found dilatation of the bronchi in four per cent of all children admitted to Mayo Clinic from 1920 to 1925. Among the patients of the adult general medical wards of the Buffalo City Hospital during this period of investigation, an average of seven percent were definitely
diagnosed as suffering from bronchiectasis (48). This occurrence is relatively high due to the fact that it was taken during the fall and winter months when the complications of this condition were more prone to occur and brought the patients to the hospital.

Riviére, Sergent, and Pottenger (48) have pointed out the frequency of occurrence in childhood. Fifty-two and nine-tenths per cent gave a history of onset between twenty-first and fiftieth year. Pottenger considered bronchiectasis beginning past middle life to be rare unless of tuberculosis or occupational fibrosis origin.

In a series of over 100 cases reported by Jex Blake (48) the highest incidence was between forty and sixty years of age, although many cases occurred between ages of ten and forty. Acland found bronchiectasis most frequent during the age period of ten to forty, with a few cases occurring after the latter age. Osler recorded it was most frequent between ages of twenty to forty. In the group reviewed by Elliott there were seven children and thirty-three adults. An analysis of fifty-one cases on service of Dr. Allen Jones (48) showed:

<table>
<thead>
<tr>
<th>Age of Incidence</th>
<th>Number of Cases</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 - 20</td>
<td>3</td>
<td>5.9</td>
</tr>
<tr>
<td>21 - 30</td>
<td>10</td>
<td>19.6</td>
</tr>
<tr>
<td>31 - 40</td>
<td>5</td>
<td>9.8</td>
</tr>
<tr>
<td>41 - 50</td>
<td>15</td>
<td>29.4</td>
</tr>
<tr>
<td>51 - 60</td>
<td>12</td>
<td>23.5</td>
</tr>
<tr>
<td>61 - 70</td>
<td>3</td>
<td>5.9</td>
</tr>
<tr>
<td>Over 70</td>
<td>3</td>
<td>5.9</td>
</tr>
</tbody>
</table>

Thus the larger number (52.9 per cent) occurred between the fortieth
and sixtieth year.

The proportion of diseased males runs as high as five to one according to Jax Blake, Anderson, and Friddle (48). Lilienthal (31) states that the disease appears to be more frequent in adults than children in proportion of about three to one, but that the sexes are about evenly divided.

Hedblom (30) states that in adults there is a distinct prominence of males, but in children of females. The increased incidence in adult males may be due to increased exposure or occupation. There appears to be a relatively much lowered incidence in the negro race (30).

GENERAL CONDITIONS:

The bronchial tree, (2) in addition to its main functions, acts as a supporting substance to the alveolar structure. Its various fixed and movable points are important factors in the performance of the various respiratory movements. In addition to respiratory movement, the bronchial system has also as its function, not only the admittance of gases, but also the discharge of fluids and mucous. Therefore, one must also consider the normal contractility of the bronchus as a factor in expelling secretions and in the performance of respiration. This has been admirably looked after in that the system consists of central tubes of large diameter which receive short tributaries. The central tube is larger in a long, thin chest, while in a thick chest it is shorter, wider, the tributaries being longer.

A clinical knowledge of the many bronchial branchings does not appear necessary, although some appreciation of the more common
divisions and the principles which govern these divisions is required. The position and arrangement of the larger tubes are fairly constant in man. The main bronchi are unequal, yet it would appear they are the products of a bifurcation. Their inequality is probably due to the position of the heart. It is almost an invariable rule that of the two diverging bronchi, the smaller one diverges most from the position of the tube; this also holds good for the tracheal bifurcation, the left product of which is more oblique as well as smaller than the right.

The lungs of an infant contain the same elements as those of adult (2), the subsequent growth seeming to be dependent on increase in size of alveoli without any addition to their number.

The larger tubes possess only as much cartilage as will insure the potency, and are not in the ordinary sense rigid tubes. The smaller bronchial tubes are totally deficient in cartilage and receive instead of give support.

The main bronchi may be sub-divided into three large groups: an extrapulmonary portion, a non-branched intrapulmonary portion, and a branched intrapulmonary portion.

**ETIOLOGY**

The dilatation in bronchiectasis may be congenital or acquired. In congenital bronchiectasis it is the dilatation only that is congenital. Only if a chronic infection develops in the congenitally dilated bronchi do the characteristic symptoms appear. When
symptoms and signs do appear they are indistinguishable clinically from those of acquired type. Hence sedative incidence is indeterminate, but most authors agree that congenital type is rare. Lauerbruch (30) believes the majority of cases to be congenital. Smith (55) describes a primary bronchiectasis.

I Congenital Bronchiectasis

The nature of the causes which bring about congenital bronchiectasis are for the most part an obscure problem. Kaufman calls it an arrested development "agenesis of the alveoli" (28). Gravitz speaks of collection of fluid in factal bronchioles (30) or as being essentially cystic foetal bronchial adenoma (Stoerch 30).

Congenital bronchiectasis is met with in two main forms. These are the so-called universal and telangiectatic bronchiectasis (5). They often fail to produce symptoms although reaching the size of a hen's egg. In the telangiectatic form the lung, or part of it, is found to be converted into a mass of cysts lined with high epithelium. The cysts may fail to communicate with bronchi. Gravitz (30) classifies as "universal" bronchiectasis dilatation of the bronchi to the involved lobe communicating with multilocular cystic dilatations lined with ciliated epithelium. Universal bronchiectasis (5) is a generalized form which is said to affect an entire bronchus by virtue of edematous degeneration. When cystic degeneration is present it usually is associated with bronchial stenosis which is due to either a true stricture or to the consequences of retained secretion and edema of the mucous membrane.
Sauerbrush and Lotzin (19) have called attention to congenital anomalies as a cause of bronchiectasis. Many, they consider due to an unusually high or unusually persistent Dust of Cuvier, a connection between the peripheral venous sinuses and the heart over which the left lower bronchus rides. They consider that the anatomical relation between the dust and left lower bronchus accounts for the predominance of bronchiectasis in the left lower lobe and they have described distinctions in the microscopic anatomy of acquired and congenital dilatation. The ridge formed by the dust exerts pressure on the left lung or its stalk. If pressure occurs early in the course of foetal development the whole left lung may be deformed; later the bronchi and their endings; later still the changes may affect the left lower lobe only, which in any event bears the brunt of the pressure. Heller & Orth (19) look upon the dilatation of the bronchi as secondary and attribute it to traction of the rapidly growing chest wall and diaphragm which finding little expansile alveolar tissue in the maldeveloped underlying lung, exert their tractile force on the bronchi.

Certain congenital types have been recognized and described under the titles "congenital cystic formation" and atelectatic bronchiectasis" (33).

Eloesser (19) describes two types of congenital cystic disease: One the solitary cyst, and the other cystic disease proper with a more or less diffuse cystic degeneration of larger or smaller parts of lung. The two forms may co-exist. The solitary cyst may lie any place in lung or sprout from other organs to which they are developmentally
attached. There is no doubt of the congenital origin of these cysts. The second form, cystic disease proper, variously termed congenital bronchiectasis, "honeycomb lung", and saccular degeneration of lung is more frequent than the solitary cyst. In this form, a whole or a part of a lobe, or even a whole lung may show various degrees of cystic degeneration. Heller and Orth (19) think they are due to a persisting fetal atelectasis in which the expanding thoracic cage, finding no yielding alveolar tissue upon which to exert its expansile force, expands the bronchi instead.

Many men still doubt the existence of congenital bronchiectasis. It is hard to prove, for the history of previous acute respiratory infection speaks neither for nor against a previous dilatation. But proof of occurrence of congenital bronchiectasis, rare as it may be, lies in the fact that cystic dilatations have been found in fetus and new born.

Intra uterine influences may play a part. A living fetus near full term is exposed within the uterus with the amniotic sac still unruptured, it can be readily stimulated to make respiratory and foetal movements (5) Graham showed that asphyxia of the foetus could be produced experimentally by ligation of uterine vessels, occlusion of trachia of mother by direct inflation of carbon dioxide by the mother. The future respiratory passages are filled with a liquid in prenatal life. The living epithelial cells of alveoli before breathing are
irregularly cuboidal with round nuclei. The cells flatten with respiration, and blood vessels distend. It is said that an atelectasis type of bronchiectasis may occur with disturbed circulation because of vein anomalies in mother, in which the alveoli do not fill and bronchi dilate. Premature separation of placenta, compression of umbilical cord, and increased intracranial pressure are other considerations.

Sandoz (5) is of the opinion that congenital syphilis might be responsible for the production of bronchiectasis and concluded that changes undoubtedly took place in utero.

ACQUIRED BRONCHIECTASIS

A. Intra Bronchial

Probably one of the most common causes of chronic bronchiectasis is the aspiration of foreign materials. Weinberg (60) particularly calls attention to the large number of cases following tonsillectomy. The material in this case is usually septic. Other common operations, as removal of adenoids, etc., plays a large part. Myerson (31) studied a series of cases and found that seventy-nine of one hundred had blood in bronchi following tonsillectomy. He believes that the absence of ciliary action or the presence of factors interfering with normal lung elasticity prevents ejection of
aspirated tonsil mixture and permits stasis and putrefaction. While most of the accidents of foreign body aspiration are related to tonsillectomy in general narcosis, they may even occur when local anesthesia is used. Moore (31) gives a very low percentage - "once in 2500 to 3000 tonsillectomies".

Other foreign bodies which may gain entrance are tacks, teeth, buttons, pins, etc. Vomitus containing undigested food may enter. When one considers the number of foreign articles children aspirate, and that bronchi are such short straight tubes, it is logical to think that many cases originate in childhood.

Lemon (33) reported thirty-two of forty-six cases gave history of disease of ear, nose or throat. Jex Blake reported thirty-seven per cent of cases due to obstruction and Elliot fourteen and four-tenths per cent.

Many men have remarked on the relationship of sinusitis to bronchiectasis, and Rist (49) compared the respiratory tract to the urinary tract in which cystitus follows renal infection. On reviewing the cases of bronchiectasis from all causes, Quinn & Meyer (49) found sinusitis to be of frequent occurrence, but less than generally supposed. The coexistence, however, is so frequent (58 per cent in this series) that investigation of the sinus is never to be neglected in cases of bronchiectasis unless, of course, the cause is evident, as a foreign body. These men also believe that sinusitis more
often causes right sided bronchiectasis. These men report experiments in which it is proved that material from nares may be aspirated and that this is more often done when asleep or under anesthesia. This should serve as a warning when operating in field of upper respiratory tract in which anesthetic is given to have patient in position to prevent this drainage.

Physiology explains this phenomena in following way: The arytenoid cartilages rest against posterior pharyngeal wall except during the act of swallowing. McLeod stated that there is a normal tonicity of the upper esophageal orifice. When the normal swallowing act takes place, the bolus causes stimulation of sensory nerve fibers to the fauces and pharynx. This initiates a series of complex movements: 1- inhibition of respiratory muscles 2- inhibition of constrictor fibers of esophagus 3- elevation of palate 4- elevation of root of tongue, and 5- elevation and drawing forward of larynx. During sleep this swallowing reflex is apparently depressed sufficiently, at least in some persons, so that fluids may be aspirated into lung.

When mucus or mucous secretion partially plug a bronchus, then each expiratory effort must compress a vesicular structure. The peripheral bronchial tubes will in the course of time become dilated. It is perhaps safe to assume, from what has been said,
that so-called postoperative massive atelectasis and patchy atelectasis play a part in the production of some cases of bronchiectasis.

Bronchial stones may act as a foreign body to cause bronchiectasis. Six of ten patients with broncholithiasis (31) showed definite bronchiectasis.

The use of zinc stearate on children sometimes leads to aspiration of quantities of this material, and the substance acts as a foreign body. Another way in which a foreign body may be introduced is submergence of body in sewage or infected water and drowning parts of lung with septic material. Comas and epileptic seizures may lead to aspiration of foreign bodies as well as anesthesia and deep sleep.

It is obvious that if a bronchial tumor occludes the lumen of a bronchus that the corresponding lung tissue will become atelectatic. If on the other hand, a tumor grows gradually, then it will be possible for dilatations to develop beyond the site of the tumor, and if there is an associated bronchitis and expectoration, these dilatations will become clinically demonstrable. In a review of 374 cases of primary carcinomas of lung Adler (5) found an extensive bronchiectasis in 36.

B. Bronchial

Constriction of the bronchial lumen is an important factor in the etiology of bronchiectasis (18). This may be high up
near the trachea or lower down in the main bronchi and their branches. A partial stenosis will permit air to enter more freely on inspiration than it will allow it to escape on expiration. It is reasonable to assume that this increase in back pressure may cause a gradual dilatation of the bronchi.

Bronchial causes of bronchiectasis are usually mucous membrane changes (atrophy, proliferation, metaplasia, ulcer formation with healing by scar); bronchitis (catarrh), loss of elastic tissue; changes in muscle and cartilage; hypersecretion or over stimulation of glands; strictures (syphilis, etc.); vascular changes, fusospirochetal disease.

Foreign bodies may cause an irritation of bronchial wall, even leading to ulcer formation. Although the foreign body is expelled, the healing of irritated area may leave a scar, with partial closing by stricture.

Concerning the role of metaplasia of the bronchial epithelium, the following may be said (5): Kawamura produced metaplasia of the bronchial epithelium experimentally while similar changes were noted in patients dying of bronchopneumonia, measles, and diphtheria. Although various men have observed this phenomena, not enough evidence has been presented to prove this a factor in cause of bronchiectasis.

In bronchitis the inflammation regularly involved trachea and larger bronchi, less frequently the smaller bronchi. The
whole process is a congestive one (5), may be superficial and limited to the mucous membrane. Although it is undoubtedly true that thick mucoid secretions may exert a valvular action in the bronchi preventing easy exit of air, still it is unlikely that this is often the sole cause of bronchieclasis. It must be borne in mind, however, when marked changes in the pulmonary parenchyma are associated with capillary bronchitis and an accumulation of secretions in the terminal bronchial tubes, that cough may then produce bronchial dilatations where it might not otherwise exist.

A disease designated as chondro-osteoplastic tracheopathy (19) may sometimes involve the bronchi. Whatever their origin they may in occasional cases cause bronchieclasis. Erosion and ulceration of a cyst wall, with suppuration, caseous degeneration and also tuberculous have been described, leading to irritation and ulceration and narrowing of lumen.

Syphilitic scars constrict the air passages (19) but are usually higher in the respiratory tract. Non ulcerative syphilis may occasionally constrict the lower bronchi. Sclerotic process of tuberculosis may be a factor. Some say tuberculosis is the cause of fifty per cent of cases of bronchieclasis.

Under the classification of bronchial causes of bronchieclasis we will consider the etiology of primary bronchieclasis as advanced by D. T. Smith (55). He considers the disease primary when no
other cause of ulceration and dilatation can be determined. He states that the essential lesion in primary bronchiectasis is a focal necrosis of the elastic tissue in the bronchial wall due to infection with the fusospirochetal group of anaerobic organisms. This group, comprising of T. macrodentum, T. microdentum, S. Vincenti, S. buccalis, fusiform bacilli, vibrios and cocci, are the same organisms that are found in pyorrhea alveolaris, Vincent's angina, pulmonary abscess, and pulmonary gangrene.

Smith observed these microorganisms in the sputum of forty-nine of sixty patients proved to have bronchiectasis by the iodized oil test, as well as in sections of bronchial dilatations. Employing fusospirochetal material from varied sources (pyorrhea alveolaris, fusospirochetal bronchitis, and pulmonary abscess), Smith was able to produce pulmonary abscesses, gangrene, and bronchiectasis in rabbits.

Control inoculations with pure cultures of staphylococcus aureus, aerobic hemolytic streptococci, anaerobic hemolytic streptococci, green producing streptococci, anaerobic streptothrix, Friedlander's bacilli, and influenza bacilli failed to produce damage to the bronchi.

Whether or not the microorganisms referred to are secondary invaders is, of course, of import, but as Smith points out, their frequent presence can not be dismissed. And certain it is that some patients with bronchiectasis whose sputum contains spirochetes...
and fusiform bacilli responded remarkably following the
exhibition of neosalvarsan (5). Jackson states that the
bronchoscopic aspect of ulcerative bronchitis due to Vincent's
organisms differs from the appearance of diphtheria and
pseudo membranous bronchitis in that the ulcerative element
predominates in the Vincent's infection.

The dilatations of bronchi found in gas warfare may
have been due (5) to mechanical obstruction of bronchi by
sloughs of necrotic membrane and exudate.

C. Peribronchial

Included in this group are enlarged lymph glands,
mediastinal adhesions, mediastinitis, intrathoracic tumors
and aneurysms (5).

Mediastinal pleurisy is probably the worst offender in
this group, and often the mediastinal pleurisy is secondary to
a primary bronchiectasis. Any evidence of mediastinal thick­
ening, particularly in a child, is very suggestive of para­
vertebral bronchiectasis.

The pressure from inflammatory exudates including
syphilitic gummate or interstitial lung abscesses may be a
cause (3).

Tumors may grow and gradually compress the bronchi
to produce bronchiectasis. The same is true in case of
aneurysm.
D. Pulmonary

The pulmonary factors include the various types of pneumonia, influenza, "pulmonary fibrosis", abscess of the lung, tuberculosis, anthracosis, etc. (5).

Early childhood is beset by so many serious diseases that may profoundly damage the respiratory tract and they often follow each other with such surprising rapidity that more than one may seem to be responsible for the crippling effect on the bronchi. Often the responsibility is divided among several possible causes and cannot be differentiated. Lemon (33) found in his series that whooping cough was the most frequent precursor of bronchiectasis and represented the causative factor, alone or in combination, in twenty-seven of the sixty-three cases. Measles was the forerunner in eight, influenza in fifteen, frequent colds and bronchitis in nine, and lobar or bronchopneumonia in eleven. Disease of the nose, throat, and accessory sinuses was held responsible in sixteen cases.

Opie and his co-workers (46) state that of the various acute infections influenza, pertussis and measles occur most frequently as causative agents. Ochsner believes influenza to occupy first place, as the incidence has increased considerably since the 1918-1919 pandemic of influenza.

Boyd (10) in review of fifty-six cases reports bronchopneumonia as the cause of twenty-three cases, whereas other acute infectious diseases were the cause in average of five.
Although Ballem (5) admits that many cases are referable to the influenza pandemic, he does not wish to place too much stress on influenza as a cause.

In children most cases of pulmonary fibrosis are consequent to the bronchopneumonia of measles, grippe, and whooping cough (5). But even the so-called croupous pneumonia may be followed by such a process. Pulmonary fibrosis as a cause of bronchiectasis is generally admitted in most cases, and the mechanics are as follows: The loss of elastic tissue causes a reduction in volume of lung. In this way an excessive unbalanced pull will act on the larynx, trachea, heart, mediastinum, and diaphragm, and is followed by a pulling of mediastinum to affected side. The heart will be pulled out of place by this mechanism. In children this usually means non-tuberculous bronchiectasis and chronic mediastinitis.

Abscess of the lung and bronchiectasis are frequently associated. Whether one or the other comes first is frequently hard to determine, but this may occur in either way.

The role of tuberculosis as an etiological factor in bronchiectasis is widely disputed, although most authors agree that it does occur. Bronchiectasis appears frequently secondary to fibroid phthisis. Grancher (30) writes that in pulmonary tuberculosis of two to four years' duration it is the rule to find there a true dilatation of the bronchi. Norris and Landis
state that in practically every case in which there is an overgrowth of fibrous tissue, bronchial dilatations develop. Lord states that tuberculosis was the underlying cause of bronchiectasis in one-third of his cases. Some writers put this as high as fifty per cent.

The same factors which ordinarily operate in the production of bronchiectasis do so in pulmonary tuberculosis(5). The "mixed infection" in pulmonary tuberculosis involves not only the mucous membrane but also the various coats of the bronchial tree. Ulceration results, and the tendency to heal with its resultant fibrosis must of necessity produce dilatations of the bronchi. Tuberculous peribronchial glands may either break into a gland or so narrow it as to produce dilatations beyond the point of narrowing. McCrae and Funk (5) have reported examples of apical bronchiectasis associated with tuberculosis. The old rule that tuberculosis is apical and bronchiectasis basal still holds true in most instances, and isolated apical bronchiectasis is usually tuberculous.

The chemical picture of pneumoconiosis (anthracosis, chalicosis, silicosis) may be that of bronchiectasis. In a recent review based on the study of two hundred eight examinations among rock drillers, blasters, and excavators in New York City (5), silicosis was found in fifty-seven per cent of men. Large areas of massive pulmonary fibrosis were not infrequently observed, but no mention is made of bronchiectasis. Anthracotic glands may compress a bronchus.
sufficiently to produce dilatations early.

Norris and Landis state (5), "Of twenty-one potters, whom I had under my observation, the evidence of dilatation of the bronchi was present in ten."

There is very little evidence that pleural effusion, adhesions, or pneumothorax can of themselves be responsible for the production of bronchial dilatations.

PATHOLOGY AND PATHOGENESIS

Although any part of the lung may be affected the basal lobes are most commonly involved (48). Of these the left lower is most commonly infected according to Jex Blake (48) and most other authors. Hedblom (30) found that forty per cent involved the left lower lobe. The location of lesion would undoubtedly be mostly influenced by etiology of condition, as those caused of tuberculosis would more probably be found in apex.

The base of lobes seems to be generally accepted to be most frequently affected. This is probably due to gravity with stasis of secretions and increased tendency for foreign particles to lodge there. Sauerbruch says that the left lower lobe is involved from eighty-five to ninety-five per cent of cases, and believes this is due to increased liability to congenital malformation as obstruction by Cuvier's duct (46). Düken (46) is of the opinion that the left lower lobe is involved more frequently than the right, because the left bronchus
comes off the trachea at a more acute angle than the right, and because the pulmonary artery crossing on the left bronchus produces a slight constriction of the left main broncus just before the upper bronchus is given off.

In bronchiectasis, there are three main types of dilatation (46): Cylindrical, fusiform, and saccular. Sauerbrush believed the saccular to be of congenital origin, and the cylindrical to be due to inflammatory changes.

Balloon and Ballam have made a classification of bronchiectasis through the use of iodized oil which I shall attempt to illustrate (2).

A great many theories have been advanced to explain the mode of sacculation. The most commonly acceptable theory is that it is of atelectatic origin. In the infant for some reason the lung may fail to expand. In the adult a condition of collapse may be brought on by obstruction either by occlusion of bronchus, the air in corresponding alveoli is absorbed by circulation so that the alveolar walls fall together. The area appears sunken, and of a translucent bluish purple color.
It is pasty and congested (39). If occlusion of bronchus is slow, the alveoli may be ruptured in an attempt to force the air out. McCallum (39) believes it is the continued pressure which causes dilatation in most cases of obstruction. He differentiates between those caused by acute inflammatory disease. In these cases he believes the infection and inflammation weaken the bronchial wall and destroys its elasticity.

Much attention has been focused upon dilatation of the bronchi and many causes have been ascribed to their production. Chief of these are: Pressure from within due to cough or the accumulation of excessive secretions, chronic inflammation of the lung, and congenital anomalies. Of these the theory of pressure from within due to cough is the most untenable. (32). The intra bronchial pressure is produced by collapse of the bronchial walls as they are forced inward by the reduction of the thoracic cage during the act of cough. It is, therefore, impossible for this mechanism to produce an intrabronchial pressure which is greater than the contemporaneous extra bronchial pressure.

McNeil and his associates (42) present the most striking explanation of those cases of chronic bronchiectasis which follow acute respiratory diseases in children, especially broncho-pneumonia. The initial change which underlies the whole process
occurs during the acute phase of the disease, and takes the form of severe acute interstitial inflammation of the bronchial wall, going to necrosis and suppuration. This causes the formation of a cavity by the loss of tissue from the bronchial wall, and excavation of a certain amount of adjacent alveolar substance in most instances. The cavity may be cylindrical or saccular in shape according to the extent of the evacuation and whether it affects the whole circumference of the bronchus equally, or is more extensive at one side. Subsequently the cavity is lined by granulation tissue, becoming fibrous, and finally may become covered by bronchialepithelium, usually of a modified type. Thus a new wall is constituted round a bronchial lumen which has been enlarged to a greater or less degree according to the extent of the initial destructive process.

According to this view, a bronchiectatic cavity is not a dilated bronchus, but an excavation in the lung substance. Destruction of tissue, not dilatation, is the essential process, although these factors may enlarge the cavity after it is formed. These may feel that many cases of chronic bronchiectasis owe their origin to broncho-pneumonia or bronchitis earlier in life. Where bronchiectasis is due to foreign bodies in lungs, the presence of infection is probably an essential factor, and the process by which the cavities are
formed may well be similar to that just described.

Lloyd (32) advances a remarkable theory for the cause of dilatation based on shrinkage of the lung. In the human body each hemitorax is a closed air-tight cavity into which the lung is expanded by a negative pressure. In the normal individual there exists a definite and fairly constant ratio between the intrabronchial and intrathoracic pressures. The constancy of this ratio depends upon the elasticity of the lung tissue and its variation depends upon the respiratory excursion. So long as normality is maintained this balance is maintained. But the entry of most abnormal conditions into the field upsets this relationship. The change is reflected also on all the surrounding structures--mediastinum, diaphragm, chest wall and even the vertebral column.

The first effect of shrinkage of the lung is to increase the intrathoracic negative pressure and to exert a traction on all the neighbouring structures which are in relation with the outside of its closed sphere. There are many ways in which this shrinkage and traction may be met and satisfied. If the loss of volume is slight it may be compensated for by the elasticity of the surrounding lung tissue without producing a change of any magnitude in the mechanics of the chest. If, however, the fibrosis has been more extensive, then greater changes
must take place. The heart must move toward the affected lung, the diaphragm rise toward it or the chest wall collapses upon it. If any or all of these adjustments combine to satisfy the pulmonary contraction completely, further tendency to distortion, including that applied to the bronchial walls, will be relieved. But where a high degree of tension continues to exist, after the maximum possible compensatory changes have taken place, then the pathologic effects of this mechanical imbalance must, and will, continue for many years to come.

It must not be forgotten that the outward traction of the bronchial walls is altered in its distribution by the movements, or the efforts at movement, of the diaphragm. Provided that the pleurae are adherent, as they generally are following chronic inflammation of the lung, the maximum effect of these movements is exerted upon the portion of the lung insinuated into the costophrenic and cardiphrenic angles. At each inspiration the diaphragm endeavors to straighten out and if unhampered, its dome moves away from the chest wall and the lung slides down upon it. In the presence of adhesions the force of the movement is applied directly by the pleura to the parenchyma of the angle of the lung and when this parenchyma itself is fibrotic and unyielding, the strain is transmitted to the hollow structures, especially the fragile bronchioles, to expend itself as a dilating influence upon their walls. It is a common and generally accepted observation that the earliest
signs of bronchiectasis following a long standing pneumonitis are precisely in these two angles and especially in the costophrenic angle, where pleural adhesions are most disturbing.

A second variable in the distribution of the influence of pulmonary contraction is the location and extent of the fibrosis. Tuberculosis produces its changes mostly in the upper lobes and other chronic inflammations have their principal effects upon the lower lobes. Although loss of pulmonary volume must of necessity subject the entire lung to a certain degree of stress and strain, this influence will naturally be most devastating in the immediate neighborhood of its producing cause and the intrapulmonary structures will naturally be best protected where the elasticity of the lung is best preserved. In this connection it may also be stated as a common and generally accepted observation that dilated bronchi are found most frequently in the same area as the fibrosis of the lung.

True bronchiectatic cavities are lined with bronchial mucous membrane, although enlargements of the bronchi occur due to ulceration and sloughing of this membrane and the laying down of a new wall of fibrous tissue. In any event Lloyd (82) has never seen a dilated bronchus unassociated with pulmonary fibrosis and it is his opinion that even in the so-called congenital dilatations, the antecedent cause lies in an intra-
uterine pneumonia or pneumonitis which fixed the atelectatic lung in situ and prevented its expansion at the time of birth. He prefers rather to show that, regardless of the particular etiologic factor concerned, the production of bronchiectasis is only a relative possibility. This possibility depends upon a fairly exact mathematical relationship which exists between the severity of pulmonary shrinkage and the efficacy of consequential accommodating adjustments in meeting and defeating its eventual effect. Where pulmonary fibrosis and loss of volume are severe but accompanied by equally important counteracting changes, there are no bronchiectasis. If the counteracting changes are moderate, the degree of bronchiectasis is moderate, and if the counteracting changes are grossly inadequate, the degree of dilatation is severe. (32).

The chronic inflammatory changes involve the whole thickness of the bronchial wall and may extend in greater or less degree to the surrounding peribronchial tissue and parenchyma. Some portions of the same dilated branchus may be hypertrophic, other sections atrophic. In the hypertrophic portions the mucous membrane is reddened, swollen, velvety, villous or polypoid and more or less redundant. Ulcerated areas may be found where the mucosa has sloughed away. In the atrophic portions it is thin, smooth or trabeculated from the projection of interlacing transverse and longitudinal ridges.
On microscopic examination of the hypertrophic portion, the mucosa is found to be thickened, uneven, and thrown into ridges and papillae. There is a marked increase in blood vessels throughout, but especially in the papillary outgrowths. The epithelium is often irregular, showing varying grades of transformation from the columnar to the cuboidal or flattened cells. In some cases an epithelial metaplasia occurs - the cylindrical epithelium is replaced by cuboidal, pavement or corrified epithelium. One may find adjacent areas of ulcerative loss of epithelium, areas of hypertrophy and islands of normal ciliated epithelium. There is marked round cell infiltration about the glands, muscle bundles, elastic fibers and cartilage. In the later stages of inflammatory change, calcification occurs in the degenerated areas, especially in the cartilage, but occurring in the mucosa and fibrosa also. The elastic fibers and muscle bundles are dissociated and in the extreme grades these elements are replaced by a thin dense wall of fibrous tissue (30).

The walls of the saccular or ampullar enlargements consist of a thin layer of scar tissue lined with epithelium. There may remain no vestige of the normal bronchial structures.

SYMPTOMATOLOGY

The early clinical history is far from typical, but should be gone into carefully, and particularly is this true of children under twelve years of age. Any history of acute
disease, operations on nose and throat, exposure to tuberculosis, or foreign body in throat should be carefully recorded.

The symptoms vary widely in regard to nature and extent of lesion, adequacy of drainage and severity of superimposed infection. Except for the acute episodes there might be little or no symptoms early, and only the associated bronchitis, chronic pneumonia, abscess formation, etc. attracts the attention to the possibility of the condition in certain cases.

The chief symptoms will be considered under various headings, keeping in mind that they may vary greatly in various patients for reasons described.

Cough: Cough is the one symptom most often present although it need not always be the first evidence of disease. In fully developed bronchiectasis the cough is usually typically intermittent, periodic, paroxysmal, and more or less voluntarily induced by bending over and accompanied by evacuation of purulent sputum. Usually the most severe paroxysm of cough occurs on rising or soon after. The cough does not disturb sleep, but the patient as a rule lies on the affected side to avoid coughing. Any movement tending to dislodge contained secretions may produce cough. The explanation of the periodicity of the cough and evacuation of the sputum is a gradually acquired lowering of the irritability of the dilated bronchi to the presence of the purulent
secretion. Only when it overflows into the more sensitive portions of the bronchial tree or other bronchi does it incite the cough reflex.

Expectoration: Sputum is usually present, but varies from scant tenacious, odorless globules, expelled with great difficulty in some, to a pint or more of extremely foul smelling pus in others. It may reach 2000 cc. in some. It is said to have a higher content of water than the sputum of tuberculosis. In children it may be swallowed and no complaint made of its presence. It is occasionally blood streaked. The sputum may separate out into the following three or four characteristic layers (6); but the order is not always followed. The upper layer is whitish or greenish yellow. It is mixed with air bubbles, pus, and mucus. The second layer is thinner, contains some of products of first layer, and less air. The third layer contains pus cells, detritus, fat rests and Dittrich plugs.

Hemoptysis: Hemoptysis is perhaps seen oftener in bronchiectasis than in any disease of childhood (10). It varies in degree from a tinging of the sputum to several ounces. It is more frequent in bronchiectasis than in tuberculosis (6). It may be the first sign to appear and last to go. It is often due to bleeding granulations, or may come from erosion of a vessel. It can be alarming, and death from pulmonary hemorrhage in bronchiectasis is not rare (6).
Dyspnea: Respiration is accelerated in proportion of amount of lung involved and fever which is present. It is not common in uncomplicated cases. The amount of emphysema present seems to determine its severity.

Temperature: Fever, sweats, and chills are significant complaints. To the patient they frequently represent repeated attacks of pneumonia. The night sweats which are frequently severe, are evidently not due to fluctuations of temperature as in tuberculosis, but to the general debility of patient. Fever is most frequently seen in children. There is no characteristic curve. Complications or lack of drainage may produce a fever, though it seldom runs above 100°C.

Pain: Pain is not a striking figure in bronchiectasis. It occurred to some degree in one-fourth of Hedblom's cases (30). It is usually pleuritis in nature.

Circulatory: Clubbing of fingers is an indication of poor circulation to the extremities. The same thing occasionally causes joint pain.

Gastro-intestinal symptoms are usually of ill omen, as they are often manifestations of amyloid disease. One must not confuse this with bronchial vomiting, as when people appear to vomit their sputum.

Cyanosis: is not usually seen in uncomplicated cases. Cyanosis gives a poor prognosis.

PHYSICAL SIGNS

There are no truly typical findings referable to the chest of a patient with bronchiectasis. The general health
of patients with bronchiectasis often remains fairly good and they are able to continue their work for years, interrupted perhaps by periodic febrile attacks incident to temporary retention of sputum. Many, however, are undernourished, anemic, listless, semi-invalids. Anemia is more common in children.

With a typical history, signs referable to the base of lung are suggestive. Particularly is this the case when they vary after the patient is postured, that is, when they change after the patient has emptied his lungs of secretions. The signs may be suggestive of areas of atelectasis and of cavitation; there may be increased whisper or diminished breath sounds. Rales of course variety and often bubbling or musical may be heard over the diseased area.

Shifting of the mediastinum to the affected side is frequently observed.

Clubbing of fingers or toes is often observed. Campbell (6) believes this to be due to lowering of oxygen tension of whole arterial blood.

Evidence of constant infection about nose and throat is often noted and plays a large part in maintaining the infection.

LABORATORY FINDINGS

The blood count may show a moderate anemia and a varying leucocytosis, with an increase of polymorphonuclear variety. The
nature of sputum has been considered. Albumin in urine should suggest the possibility of amyloid disease.

DIAGNOSIS

The diagnosis of bronchiectasis should be considered incomplete unless one is able also to diagnose the location of the disease, size and distribution of dilatations, the degree of fibrosis as evidenced by atelectasis and shift of mediastinal contents, the nature of the process, whether tuberculosis or not and the presence or absence of various local or systemic complicating features, such as foreign body, pulmonary abscess, bronchial stenosis, carcinoma, empyema, brain abscess, amyloid disease, etc. A careful and prolonged examination requires the employment of the following sources of information: clinical history, physical findings, laboratory findings, ordinary roentgen-ray findings including fluoroscopy, bronchography, bronchoscopy, diagnostic pneumothorax.

Clinical history and physical findings have been discussed. Boyd (10) believes that a diagnosis of bronchiectasis should be considered: (a) when cough, particularly with sputum, persists more than a few months following such diseases as pertussis, measles, influenza or bronchopneumonia; (b) in so-called chronic bronchitis, particularly if clearing up of infectious foci in upper respiratory tract does not give improvement or cure, (c) in those having repeated attacks of bronchopneumonia, if these
continue after eradication of infective foci. Hemoptysis or night sweats make diagnosis more likely. Changing of physical findings in lower chest after postural drainage is indicative.

The ordinary roentgen ray film of the chest in many cases permits one to diagnose bronchiectasis, but no diagnosis is complete without a lipiodol injection (6). Increased hilus detail which extends down to the base and "circular" shadows are very suggestive of bronchiectasis, although the former may only be the branches of the pulmonary vessels. Fluoroscopic examination frequently enables one to discover that such increased detail is associated with an area of paravertebral atelectasis or chronic mediastinitis which extends from behind the heart. The fluoroscopic examination is of particular value, since it tells whether the diaphragm is fixed, the condition of the mediastinum, and whether or not the heart shifts with change of position. The "honeycombing", seen particularly in the lower lobes, is pathognomonic (10).

Bronchoscopic examination by the technique of Chevalier Jackson was a valuable aid to diagnosis. It is of aid for the following reasons (6):

1. It enables one to rule out the presence of a foreign body, new growth or bronchostenosis.

2. It permits one to observe which bronchi are discharging pus.
3. It allows the most complete lipiodol injection since it is possible to aspirate secretions and remove granulations before introducing the oil. By this method one can also direct the oil to the desired area. Most important of all, it permits of a more exact interpretation of the injecting picture. It excludes many cases of unexplained hemoptysis.

4. It is possible to obtain uncontaminated cultures by this method.

As has been shown the ordinary roentgenogram may be misleading. The introduction of the principle of contrast media roentgenography in the study of the bronchial tract represents the greatest advance in the differential diagnosis of this condition since the advent of the roentgen ray method. It is comparable to the same methods as used in gastro-intestinal and urinary tract disease. It not only definitely establishes the diagnosis but makes the diagnosis early enough that the condition is amenable to treatment.

The first attempt at the use of contrast media was made by Springer in 1906 (30). He injected iodoform and bismuth into trachea of dogs. In 1918 Jackson used bronchosopic insufflation of bismuth into trachea. In 1919 Weingartner injected anhydrous oxide of thorium into trachea and obtained good pictures. In 1920 Lynch demonstrated a lung abscess by bismuth and oil (30). Forestier and Secard in 1923 published their method of lipiodol
bronchography which today is the most widely used of the contrast media.

Iodized oil has become the most used of the contrast media. Numerous oils have been tried, but lipiodol is still the most popular. Some of the iodized oils are lipiodol (Lafoy), which consists of forty per cent of iodine by weight combined with poppyseed oil, iodopin, which contains forty per cent iodine by weight in sesame oil, or may be obtained in ten to forty per cent compounds (52). Deusse (17) calls attention to an American product which is used in his clinic, iodochloral. In this oil, peanut oil forms the base. The iodine content is 27.5 per cent and in addition it contains 7.5 per cent of chlorine. As the action of iodine and chlorine may be complementary this combination may cast a better shadow than iodine alone. It is the only oil to which a flavoring oil has been added to increase the palatability.

It is interesting to know that the iodine is so firmly combined with the oil that the iodine reaction cannot be obtained in patients who are expectorating the sputum combined with oil. Iodized oil is not rapidly broken down in lungs but may be in gastro-intestinal tract to produce iodism (38).

Tucker (39) believes that bismuth subcarbonate insufflation as originated by Jackson has given the best results in outlining the trachea and larger bronchi and in bronchiectatic dilatation in larger bronchi. Iodized oil, forty per cent, he
considers best in abscess cavities, and in periphery of lung. He also believes bronchoscopic introduction to be the best method.

Singer (35) had a patient who received bismuth in oil which later acted as a foreign body in lungs, with a resulting obstructing to drainage.

The various methods of injection of iodized oil are as follows: (6)

I Supraglottic
   a. Aspiration method
   b. Supraglottic method

II Transglottic
   a. Catheter
   b. Intubation tube
   c. Bronchoscopic

III Subglottic (transcutaneous)
   a. Tracheal puncture, intercricothyroid

The supraglottic method is the simplest of all, consisting in introducing the oil by means of a syringe through a curved cannula into the glottis. The oil passes through the open glottis into the trachea and the most dependent portion of the bronchial tree. Pritchard (30) describes the method as follows:

"In some patients the injection can be made without local anesthesia, but a better procedure is to swab the pharynx, velum,
and base of tongue with a ten per cent cocaine solution. After
an interval of three minutes, 1 cc. of warmed one per cent
cocaine solution is dropped into the glottis with the aid of a
laryngeal mirror, syringe, and curved cannula. Five minutes
later the injection can be made. The patient sits facing the
operator and slightly inclined toward the side to be injected,
and is instructed to pull the tongue forward and breathe
normally throughout this stage of operation. A 20 cc. syringe
filled with warm iodized oil is firmly attached to a six inch
cannula, having its distal end curved to a right angle or less.
With the aid of a laryngeal mirror, the tip of the cannula is
introduced behind the base of the tongue held over the glottis,
and oil is slowly expelled from the syringe into the larynx."

Singer simply injects the oil on the base of the tongue
pulled forward, the patient meanwhile being instructed to
breathe (53). This is much the manner used by Weinberg (60) in
his demonstration.

Ballon and Ballon (2), Mainzer (34) and many other men
prefer the bronchoscopic method. It allows the secretion to be
evacuated, and if the disease is bilateral the oil may be placed
on both sides equally well. Again, should any acute infection
exist along the bronchial tree, the endscopy would detect it
at once.

The technic by Mainzer is as follows: (34) The mucous
membrane "of the posterior pharynx" is anesthetized with 10 per
cent cocaine. The patient is placed in a partial upright position
and instructed to breathe during the entire procedure. Then the
laryngoscope and bronchoscope are passed. As the bronchoscope is placed in the upper trachea a small sponge saturated with five per cent cocaine is passed through the bronchoscope and the living membrane of the trachea partially anesthetized. The bronchoscope is passed to the carina. If the left lower lobe is involved the bronchoscope is passed into the lower bronchus. Aspiration is carried out and should the condition be bilateral the same procedure is carried out on that side. After the secretion is removed, the warmed oil, 20 cc., is passed from a large glass piston syringe through an aspirating tube. When a unilateral condition exists the entire amount is placed in at the same time; when there is a bilateral involvement, 10 cc. are placed in each lower bronchus. Thus the bronchoscopic method allows another helpful procedure as equalization of oil can thus be had. The bronchoscope is now withdrawn following the injection of oil and the patient is taken to the x-ray rooms. The oil outlines with precision the size of the cavity formation.

DIFFERENTIAL DIAGNOSIS

The differential diagnosis involves chiefly the exclusion of chronic bronchitis, unresolved pneumonia, pulmonary abscess, pulmonary tuberculosis, empyema with bronchial fistula, subdiaphragmatic abscess perforating into a bronchus, and malignant disease of the lung.

A chronic bronchitis with purulent or mucopurulent sputum is a frequent forerunner and simulates bronchiectasis so closely
that a contrast media roentgenogram is necessary. If dilatation is not found it is well to remember that it may develop at any time if symptoms persist. Many cases of bronchiectasis are observed over a long period of time under the diagnosis of bronchitis.

An unresolved pneumonia is one of recognized causes of bronchiectasis. An ordinary X-ray plate would show evidence of consolidation. Contrast media may be used to determine presence of dilatations (11).

Abscess and gangrene have an acute onset and course. The patient appears very ill, he displays a septic type of temperature, and examination of blood may show a marked leucocytosis. The sputum is usually typical and is referred to as "prune juice" sputum (11). Both conditions are more rare than bronchiectasis.

Foetid empyema may simulate bronchiectasis by rupturing into a bronchus by a fistula or by soaking of pus through spongy lung tissue into a bronchus and expectoration of a copious foul sputum. History and X-ray examination make the diagnosis.

Pulmonary tuberculosis occurs typically at opices and bronchiectasis at the bases, but, reverse may be true. The diagnostic standards given for non tuberculous cases by the National Sanatarium Association is best to rule out all non-
tuberulous cases, and is as follows (14):

1. No persistent rales in upper half of chest.
2. X-ray negative or showing slight peritruncal lesion.
3. Tubercle bacilli never found in sputum.
4. Complement fixation test for tuberculosis, positive or negative.
5. No reaction to old tuberculin (subcutaneous) once repeated.
6. Constitutional reaction to test or upon repetition without focal reaction as determined by physical signs (rales) or X-rays.
7. No history of unexplained hemoptysis of teaspoonful or more.
8. No history of unexplained pleurisy with effusion.

COMPLICATIONS

Complications arise chiefly from local extension and metastatic spread of infection. Ulceration of the bronchial wall and an adjacent large blood vessel may result in fatal hemorrhage. An aneurism rupturing into a bronchial cavity is reported. Lymphatic extension of infection results in a chronic interstitial pneumonia may arise from extension. Carcinoma of dilated bronchi have been reported. Empyema occurs by extension, myocardial damage may be assumed in cases of long standing. Toxic absorption is a factor, and many cases of nephritis have been reported.
The causes of death (30) are chiefly marasmus, pneumonia, gangrene, empyema, cardial decompensation, haemoptysis, and cerebral abscess.

PROGNOSIS

A spontaneous cure of a chronic bronchiectasis of advanced grade is not to be expected and a restoration of the damaged bronchus is impossible (30). Spontaneous healing of bronchiectasis of slight grade and short duration may occasionally occur. Hedblom states (30) that "postural drainage, an equable climate, and a general hygienic manner of living bring about marked improvement in most cases and reduce the tendency to complications, but when such treatment is interrupted the patient relapses into his former condition and the disease regresses.

Some authors have claimed that bronchiectasis is curable. Nobecocrt thinks this is brought about by the dilatation of bronchi ceasing to increase, and, as the lung grows, the bronchi ultimately coming to have the normal proportions. Hutinel believed that the younger the age at which bronchiectasis appeared the most likely was a cure to result. Findly & Graham do not support that contention.(21)

The great difficulty in past on matter of prognosis in bronchiectasis was the uncertainty of diagnosis of the mischief by physical examination. There are examples with signs and no symptoms, and examples with symptoms and no signs. In fact,
it is only with the aid of intratracheal injections of lipiodol that a definite diagnosis can be made in any case. Not only can presence of bronchiectasis be affirmed, but the degree of bronchial dilatation can be appreciated.

Findley and Graham (21) report fourteen cases still living which have been under continuous observation since the date of their first lipiodol injection. From a review of the fourteen cases, all observed over a longer period than three years, it is seen that a pre-existing bronchiectic condition can disappear, but that in each of the cases in which this was observed the degree of dilatation was slight. It is probably the cases of shortest duration which are most likely to recover, but experiments show it more likely to be a matter of the cause of inflammation, than the age of the pulmonary fibrosis which determined its liability to disappear or progress. The conclusions drawn by Findley & Graham are (21):

1. The prognosis in bronchiectasis in childhood is grave as the condition usually steadily gets worse and leads to a fatal termination.
2. Undoubtedly bronchiectasis following a chronic pneumonia may disappear but only when the dilatation is slight.
3. The age of onset of the bronchiectasis would seem to influence the course of events; recovery is more probable in the examples which develop later in childhood.
4. During childhood the duration of the illness is of no prognostic help.
PROPHYLAXIS

The prevention of bronchiectasis should be considered in relation to the infection that weakens the bronchial wall and to the mechanical factors which produce the dilatation. Recurring colds and bronchitis are an expression of lowered resistance to be combatted by hygienic measures. Sinustis has been pointed out to be often associated and chronically infected sinuses should be treated. Much the same should be said of oral sepsis. Care should be taken in operations on nose and throat such as tonsillectomy to prevent aspiration of infected material. Early bronchoscopic removal of a foreign body prevents permanent bronchial damage. Early adequate drainage of a pulmonary abscess is essential. Prompt thorough drainage of empyema prevents pulmonary sclerosis and pleural thickening which is one cause of bronchiectasis. The convalescence from bronchopneumonia, particularly that complicating the infectious diseases of childhood, should be supervised with special care, and persistent bronchitis should receive energetic treatment. It may be said that each condition recognized as a cause of bronchiectasis should be treated with idea of prevention of this complication. Prevention of development of atelectasis should be strived for, and in case it does develop we should try to counteract the tension by some such means as phrenicotomy.

TREATMENT

Treatment of bronchiectasis is divided into nonoperative
and operative groups. The consensus of opinion is that medical treatment should be tried. Early diagnosis is surely essential and it is in these cases that nonoperative treatment is of greatest value. Medical treatment is surely of value even if used with surgical treatment. To quote Harrington (27), "There is no accurate method of determining the number of patients who respond to conservative measures but it is generally believed to be more than fifty per cent. In the remaining fifty per cent it is important to recognize any surgical indications before the disease becomes progressively worse. It is doubtful whether conservative means should be continued for more than six or eight weeks if there has not been a gradual marked improvement, as in many cases early surgical treatment will save the patient from extensive chronic pulmonary disease."

Most patients should receive both medical and surgical care. Occasionally some recover or fail to progress under conservative treatment, but most cases go on to a chronic bronchiectasis.

The age of patient, mode of origin, nature of lesion, presence or absence of local or general complications are all important considerations. A bilateral lesion obviously increases the hazard. Ewart (7) states that mere fetor is not in itself an alarming sign.
NON-OPERATIVE PROCEDURE EMPLOYED IN TREATMENT OF BRONCHIECTASIS

I Rest  II Diet  III Climate

IV Postural drainage  V Thirst Cure  VI Heliotherapy

VII Intravenous therapy - neosalvarsan, colloidal silver.

VIII Direct intrabronchial application of drugs by syringe or spray.

IX Irrigation of lung (bronchial lavage)

X Inhalations of superheated air with a mixture of suitable drugs.

XI Vaccine therapy

'as outlined by Ballon, Singer, Evarts, Graham (7)'

I Rest is evidently helpful in cases of bronchiectasis as is shown by their improvement in tuberculous sanitaria. However, as the disease is characterized by remissions and seasonal variations we must not feel that cure develops with an improvement. Rest should be used even when surgical treatment is attempted.

II Many forms of diet have been tried including those rich in vitamins, but none seem to give appreciable results.

III Climate has probably been overrated for patients with bronchiectasis as well as for other pulmonary conditions including tuberculosis. Certainly a milder climate predisposes less to colds, hence may lessen acute exacerbations. Patients with bronchiectasis should, however, keep away from atmosphere with irritating gases.

IV Postural drainage seems to be the most valuable of conservative means. It is the simplest method of promoting thorough evacuation of the sputum. Postural drainage should be tried before
any other form of treatment is suggested. Intermittent or continuous methods may be used. The continuous method is accomplished by changing the position of the bed. Lifting the feet high enough to permit gravity drainage is the principle. Singer (7) recently advocated a bed suitable for this purpose. The intermittent method is advocated by many. Marvin (36) used it considerably in his treatment which was entirely conservative, and obtained good results. He started drainage at earliest opportunity, and had it practised two or three times a day in all cases and as often as every hour in those severely inflicted. It should not be continued for more than several minutes at a time. Marvin (36) uses the adjustable table drainage apparatus and a horizontal bar or jack knife drainage method. He believes the jack knife drainage method better as it more completely removes the secretions. Often lying across a bed will accomplish results.

V The thirst cure advocated by Singer is effective in temporarily reducing the amount of secretions, but that in itself does not change the pathological process (30). Singer himself gave it a fair trial and showed it to be of little or no value.

VI I have found no author who recommended this type of treatment. The good results of sunshine and fresh air in building up resistance should not be underestimated. Heliotherapy is not mentioned by most writers.
VII Intravenous therapy has been referred to in mention of fusiform bacilli and spirochetes as a cause of bronchiectasis. It is of value in some cases where this type of organism is found in sputum. It is most valuable where there is adequate drainage and little retention of secretions. In some cases the results are striking (7) but many times the patients fail to respond even when fusiform bacilli or spirochetes are found in sputum. Although the results may not be depended upon, intravenous medication may be helpful in combination with other forms of treatment. Neosarsphenamine is used more than any other drug intravenously.

VIII Direct intratracheal application of drugs has been used a great deal since introduction of lipiodol. A great deal of controversy arises as to its value in therapy in bronchiectasis.

Mainzer (34) states that iodized oil has a therapeutic effect in bronchiectasis, such as:

a. Lessening the amount of expectoration
b. Reducing the number of bacteria in the sputum
c. Lessening the toxic symptoms
d. Reducing the size of the dilatation.

Ballon, Singer, Graham, Evart (7) admit that many patients feel better after lipiodol injection but if followed
over long periods of time are subject to acute exacerbations. They state that they have never observed the disappearance of dilatations and cannot admit that the use of lipiodol in the manner described has resulted in any lasting cure of any of their patients with bronchiectasis.

These same men do not believe that the iodine in poppyseed oil has no bactericidal properties. They found that agar plates and lipiodol mixture gave a luxuriant growth of many organisms. D. H. Ballon (4) believes that the beneficial results are due practically entirely to the fact that the lipiodol can displace the sputum.

Ochsner (45) feels that the repeated introduction of iodized oil into the tracheobronchial tree is of distinct value in the treatment of bronchiectasis. He states that not only is there a marked improvement in the clinical symptoms, and signs, as evidenced by the diminution of cough, a decrease or disappearance of sputum, an increase in the appetite with a gain in weight, and a general feeling of well being in the patient, but also bacteriological examination of sputum shows an actual decrease in number of organisms. He claimed also a disappearance of fetid odor. He does not claim a return of bronchi to normal character in
advanced cases, but a sterilization of the bronchiectatic cavities.

Weinberg (60) demonstrated in his lectures by means of films the long periods of time the lipiodol will remain in lung. He believes it to be of decided value in therapeutics. Deus (17) believes iodized oil to be of advantage but indicates that there are certain dangers entertained by its use. Turner (59) is an advocate of the use of iodized oil in treatment of bronchiectasis.

IX Bronchial irrigation or lavage were first carried out by the bronchoscope, there are some who use the soft rubber cone catheter. Still and Wooding (7) use a hypertonic solution of saline and reported thirtyfive per cent symptomatic cures in one hundred cases. Most men prefer postural drainage and bronchoscopic aspiration whenever possible, and advocates of lipiodol hold that lipiodol accomplishes the same result with less reaction.

X Inhalation of superheated air with a mixture of such drugs as eucalyptis oil, etc. as a means of treating bronchiectasis has been discarded.(7)

XI Vaccine therapy has been experimented with considerably but little has been accomplished in most cases. A few striking improvements are recorded in the literature. Most clinics do not use vaccine therapy.
The introduction of the bronchoscope by Chevalier Jackson has been a great aid in the diagnosis and treatment of bronchiectasis. Until that time it was necessary to rely chiefly on physical findings, and even the X-ray only permitted us to see the difference in densities from the outside. With the bronchoscope we may have a direct view within the bronchi, hence facilitating diagnosis for whatever treatment is desired. Moreover, the bronchoscope has been a great aid in treatment by the direct method of drainage of diseased areas. It is here that its chief value lies. We have shown that this is the purpose of postural drainage, but it is doubtful if this method can ever empty a bronchus as completely as the bronchoscopic method.

The value of bronchoscopic aspiration of secretions preliminary to lobectomy and thoracoplasty and after the latter procedure is also acknowledged by those who are alive to the fact that the spilling over of secretions into the opposite...
lung may in such cases prove fatal. Ballon (4) and Clerf (16) believe that the bronchoscopic treatment is the best of the conservative means at our disposal for establishing adequate drainage. Marvin (36) an exponent of postural drainage, believes bronchoscopic drainage to be more effective.

Ballon (4) treated sixty-two cases bronchoscopically, which included the removal of obstructions to drainage, aspiration of pus, and local medication. He comes to the conclusion that the condition is not always progressive, and that the more severe forms of bronchiectasis call for surgical interference.

Clerf (16) states that "if the bronchiectasis is due to obstruction it can be successfully treated by bronchoscopy. In monolobar bronchiectasis where there is no obstruction and in bilateral involvement, bronchoscopy in adults is largely a palliative measure, being an aid to the surgeon or internist. Repeated aspirations together with endobronchial medication will aid in decreasing the amount of pus, relieve the stagnation and fetor, improve the condition of the bronchial mucosa, thereby aiding the activity of the cilia and increasing the effectiveness of postural drainage." Clerf also finds that the most satisfactory results in bronchoscopic treatment of bronchiectasis is in children. He
calls particular attention to the large number of cases associated with sinusitis.

Martin (35) obtained fifteen clinical cures in a series of sixty-one cases by the bronchoscopic method of treatment. He is of the opinion that bronchoscopic treatment may be, with profit, combined with lavage.

It may be admitted by most writers that no method such as bronchoscopy will ever cure a patient with advanced bronchiectasis, but it is certain that many such cases may be rendered fit members of society.

The technique as given by Ballon (4) is as follows: He prefers to give bronchoscopic treatment in the morning. The treatment may be proceeded by postural drainage, and if sufficiently successful, bronchoscopy may be dispensed with. In children no preliminary preparations are made. No breakfast is given, and no anesthetic, local or general is used. Adults are sometimes given a preliminary hypodermic injection of morphia, grains 1/4, and atropine, grains 1/150. A local anesthetic of ten per cent or twenty per cent cocaine with a few drops of adrenalin is used to anesthetize the larynx. The bronchial tree is inspected for abnormalities, and purulent secretion traced to its source.

XIII Pneumothorax

If the principle of pulmonary collapse is accepted, pneumothorax is a rational method. The chief recommendations are the
simplicity, safety and possible ultimate restoration of lung function. The method is naturally limited to those cases in which the lung pleurae are not adherent and the lung parenchyma are not involved. It possesses the disadvantage that refills are necessary for a prolonged period of time, even if it is safe ultimately to allow the lung to expand (30).

Tillman (quoted in 30) found remarkable results in his series of sixty five cases. Eleven were slightly improved, seventeen remarkably improved, and sixteen remained free from symptoms up to one year. No lipiodol was used in these cases.

Ballon, Singer, Graham (30) do not recommend pneumothorax. They feel that it does give improvement in some cases, but that if improvement does not occur in three to six months, it is not likely to occur, and should be supplanted by some other mode of treatment. They feel that pneumothorax is often of value in preparing the patient for a major operation.

Russell (51) believes that in the very early cases collapse of the lung is the most useful and rational procedure. He states that artificial pneumothorax is the easiest and most simple method. Various gases have been used for this purpose, but atmospheric air is generally now in use and is all that is necessary.

XIV Oleothorax

Oleothorax has been substituted for pneumothorax as a means of maintaining the collapse for a period of six months or more and it has its advocates (51). The procedure consists
in introducing a solution of olive oil impregnated with antiseptic instead of atmospheric air and the idea is to obviate repeated fillings and to maintain a collapse effect for a period of months.

The U. S. P. preparation of paraffin oil may be used (7). To every 95 cc. of liquid paraffin is added 5 cc. of five per cent gomemol. A small amount of lipiodol or brominol may be added for roentgenologic visualization.

XV Compression by means of pack and plombage.

This method will not be discussed to great extent as very little appears in literature regarding this method. Graham (7) in 1921 was first to recommend intrathoracic compression by gauze packs in the treatment of bronchiectasis. Whether or not gauze or oil is used does not seem to be of great moment, as the principle is the same.

XVI Thoracoplasty

Extrapleural thoracoplasty involves the collapse of the lung by extensive rib resection. There is a great deal of controversy over this type of treatment. Helblom (30) has reported probably the largest number of cases, and states that "it is not an ideal operation, as it does not remove the disease, but in properly selected cases it produces improvement approximating a cure. Of all methods of compression it is most applicable. It produces a degree of
collapse which can be made to approximate that following artificial pneumothorax and which is not limited by adhesions." He believes that the most favorable type is the early peripheral cylindrical lesion in patients in whom phrenic evulsion has not produced sufficient improvement. It is his opinion that early thoracoplasty will relieve the excessive grade of negative intrapleural tension incident to an atelectasis and that it will prevent the formation of sacculations. Mediasteral displacement and marked retraction of chest wall due to fibrous tissue retraction in cirrhotic type of bronchiectasis, he considers a mechanical indication for mobilizing the chest wall.

Russell (51) calls attention to the fact that thoracoplasty is a grave operation, and that matter of irrevocability has to be considered. The results are not merely permanent, but also mutilating.

Lilienthal (31) states that in bronchiectasis, thoracoplasty should be reserved for general one sided disease in which the patient shows little chance of surviving pneumectomy. Individuals over twenty-five years of age and even younger ones whose cases show signs which point to great technical difficulty in attempts at radical cure should be considered.

Harrington (27) considers surgical collapse of
lung by extrapleural resection of the ribs to have its chief application in the treatment of the diffuse and unilateral types of bronchiectasis with small abscesses disseminating throughout the lung and in cases in which coalescing central abscesses have established drainage through a bronchial fistula, particularly when these lesions are associated with severe hemorrhages.

Ballon, Singer, Graham (7) report that their results following thoracoplasty for bronchiectasis have not been striking. The method consists generally in removing eight to ten centimeter segments of the ribs subperiosteally. The third or fourth to the eleventh inclusive are generally resected. The work is performed in multiple stages, the number depending on condition of patient and the operator. Rarely less than three or more than five stages are required. (27) The ordinary interval between stages is eight to twelve days, but longer time may be necessary. The operation is done under combined local and nerve trunk anesthesia with a little nitrous oxide and oxygen anesthesia as indicated (31) The nerve trunks are isolated and injected with a few drops of ninety-five per cent alcohol at end of operation.

PHrenicectomy

Unilateral diaphragmatic paralysis by interruption of the corresponding phrenic nerve is the most recent of the
principal methods of securing, by therapeutic collapse, that combination of rest and compression which plays so large a part in the successful treatment of chronic pulmonary diseases. With this object it may be used alone, or in conjunction with such methods as artificial pneumothorax, multiple intercostal neurectomy, and thoracoplasty. (47)

The operative procedure now generally employed consists of avulsion or exsirisis of the phrenic nerve through a small incision above the clavicle, for a distance sufficient to ensure breaking its connection with the supra-pleural plexus and all accessory fibers. Although usually successful, this method has been known to fail in the production of a permanent paralysis even after as much as seven inches of nerve have been evulsed.

In addition to these permanent methods a number of operations have been devised by which a temporary paralysis may be effected in order to permit of healing of a tuberculous lesion and of a subsequent return of function of the diaphragm. These methods include crushing, freezing, alcohol injection, and section with immediate suture of the nerve, and are generally considered less satisfactory than the permanent operations.

In bilateral basal bronchiectasis, however, the crushing operation has been successfully combined with phrenic avulsion in the following way. The phrenic nerve is crushed on the worse side, and the effect of a temporary paralysis on cough and sputum observed.
If satisfactory improvement results, then the opposite nerve is crushed or avulsed, and the paralysis is later made permanent. (47)

The complications of the radical operation fall into three main groups: (a) those due to failure in technique; (b) those due to adhesions in the course of the nerve; and (c) reflex disturbances.

In the first group haemorrhage constitutes the most frequent and serious of all complications, and results in from injury either to the pericardiophrenic artery (which accompanies the nerve and venae comites in the same sheath) or to the subclavian vein. The former is readily controlled, and never fatal; the latter is far more serious, and has been responsible for the majority of the very few deaths that have been reported. The vein may be torn as the result of tension on the sling formed by the phrenic and accessory phrenic nerves, which pass respectively behind and in front of the vein; the accessory nerve, however, almost always breaks first. Air embolism is said to be more common in phrenicotomy than in phrenic evulsion, but can be avoided by prompt and careful arrest of haemorrhage.

The nature of the complication in the second group depends upon the structure to which the nerve is adherent, and varies from slight haemotysis (when infiltrated lung tissue is unduly stretched) to cold abscess formation, pneumo- and pyopneumothorax, and even to fatal mediastinitis when caseous foci are opened up. The presence of a tuberculous empyema, and of pleural
adhesions over the nerve, are considered by some definite contraindications to avulsion.

Reflex disturbances are cardiac and respiratory, and probably owe their origin to interference with the vagus and intercostal nerves. They are usually slight and transient in nature, consisting of tachycardia, alterations in pulse volume, and dyspnoea.

The sequels are insignificant and of short duration, consisting most commonly of pain in the corresponding shoulder and more rarely of tachycardia, dyspnoea, and digestive upsets, which are as rare on the left side as on the right.

If the operation approach to the nerve is through the subclavian triangle just below the omohyoid muscle, for the reason that if anomalies of the nerve are encountered or accessory fibers have to be dealt with, they can best be exposed in this triangle whereas they might not even be discovered and are not easily exposed if the approach is higher up in the neck (37).

Since the phrenic nerve lies normally upon the surface of the anterior scalenus muscle, the most accessible approach to the nerve in the subclavian triangle is determined by palpating the belly of the anterior scalenus by pressing the fingers beneath the posterior belly of the sterno-mastoid muscle. The skin and subcutaneous tissues at the site selected are next
infiltrated with about 10 cc. of 0.5 per cent novacaine solution. The incision is made 2.5 to 3 centimeters long and extends transversely between the posterior border of the sternomastoid and the external jugular vein, following one of the natural folds of the skin 2 or 3 centimeters above the clavicle. One can readily approach the phrenic nerve through this incision and even make a thorough search for accessory or communicating fibers over a rather wide area by retracting the wound. This incision has the advantage of leaving a scar which is scarcely recognizable after a few weeks.

After having made the skin incision, the superficial fascia, platysma, deep fascia, and pyramidal fat body are carefully separated by blunt dissection. One then comes directly upon the surface of the anterior scalenus muscle which is exposed. The phrenic nerve, if occupying its normal position, will be found coursing downward and inward over the surface of the anterior scalenus. After positive identification and search for anomalies, the nerve is separated from the muscle sheath. If the direction of the nerve from the muscle sheath is painful, one cc. of novocaine is injected into the muscle immediately beneath the nerve fiber to relieve further distress. After freeing the nerve from the muscle sheath, it is picked up by a hooked tenaculum, injected with 0.5 cc. of novocaine, classified with a hemostat, and sectioned high up. The nerve is then carefully evulsed by making gentle traction upon the hem-
ostat, or by winding the nerve on the hemostat, which is rotated on an anatomical forceps. If the nerve is not adherent to other structures in the mediastinum, it slips from its sheath with ease. The patient is unaware of the procedure until the nerve parts company with the diaphragm, at which time a sudden "thud" in the region of the epigastrium may be experienced.

After complete interruption of nerve impulse to the hemidiaphragm has been effected and adhesions do not prevent, the diaphragm immediately assumes position of expiration, and is motionless on quiet breathing. It continues to rise gradually throughout ensuing months by muscle degeneration and atrophy. The collapse provided by a hemidiaphragmatic paralysis under the most favorable circumstances can amount to scarcely more than a reduction of one-sixth to one-third of the lung volume (37).

Again there exists among different operators a difference in opinion as to results obtained by phrenic exairesis. In summarizing a large number of cases Ballon, Singer, Graham (7) state that "apparently an individual patient with bronchiectasis has only a relatively small chance of being improved by the operation of phrenicectomy and, on the contrary, a definite chance of being worse. Moreover, even when improvement occurs it is usually not lasting."

Oakley (47) concludes that:

1. Phrenic avulsion in experienced hands is a safe operation, and the complications are more to be feared in theory
than in practice.

2. Only in strictly basal and unilateral cases of bronchiectasis can phrenic avulsion be reasonably expected completely to relieve the symptoms.

3. Improvement is to be expected in unilateral bronchiectasis in which the lesions are confined to the bases and not advanced on the better side.

4. In unilateral bronchiectasis in which the lesion extends into upper or mid-zones, temporary improvement is the rule, but relapse must be expected unless thoracoplasty is performed.

5. In bilateral basal bronchiectasis with lesions in upper or mid-zones, little benefit is to be hoped for from unilateral diaphragmatic paralysis.

6. As a preliminary to thoracoplasty phrenic avulsions should always be performed, but should not be allowed to shelve the larger operation in event of a brilliant but temporary cure.

Hedblom (30) believes that phrenic nerve evulsion is no simple and safe an operation and probability of improvement is so considerable that it should be done in all early unilateral cases.

XVIII Ligation of a branch of pulmonary artery

This method of treatment has been used particularly in
the hope of influencing hemoptysis. Very little appears in literature concerning this method. Meyer (7) reports good results. There would appear to be some danger of infarct and abscess.

XIX Pneumotomy

If one could be assured that there is only one dilated bronchus this method might be effective. It is obvious, however, that incision and drainage of a dilated bronchus in presence of other dilated bronchi would not be sufficient treatment. Hence this method is largely discarded.

XX Cautery Pneumectomy

Graham (8) in 1923 proposed the use of cautery as a safer substitute for the ordinary lobectomy in cases of chronic suppuration of the lung and also in such cases in which an attempt at lobectomy must be abandoned because of two extensive adhesions or other reasons. He reports that bronchiectasis associated with multiple lung abscesses and chronic lung abscesses with secondary bronchiectasis are the types most suited for cautery pneumectomy. This type of operation seems indicated where there is septic temperature, leucocytosis, etc. Graham reports fifty-four cases operated by this method in which two-thirds were definitely improved, and operative mortality was only eleven per cent.

Lilienthal (31) is impressed by Graham's results but is not enthusiastic about the method of cautery pneumectomy. He does feel that this important advance should be given a thorough
test by thoracic surgeons. Hedblom (30) feels this to be a rather dangerous procedure.

The method consists (8) of turning up a large flap of entire thickness of chest wall of the affected portion of lung. The pleura and lung should be adherent, and if they are not, adhesions should be made. With an ordinary soldering iron raised to a red heat, an excavation is made in lung tissue. Many pus filled bronchi may drain. If there is an old drainage tract the iron is plunged into it, and then worked out from that point. The operation may be divided into as many stages as necessary.

XXI Lobectomy

We have been considering as means of treatment only the palliative measures, in which cures only occasionally result. We have shown the wide variance of opinion as to how conservative or aggressive treatment should be. We now come to the treatment which would seem to be ideal, that is, extirpation of the diseased lobe. This operation is now becoming increasingly popular, but even those surgeons using the method most, admit to the fact that it is exceedingly dangerous.

Lilienthol has performed more lobectomies than any man in America. He reports a mortality of forty seven per cent (31). He does feel, however, that it is the operation of choice, and that the chronic sufferers will gladly undertake the risk to become fit members of society.
Whittmore (62) reports six cases with a mortality of one hundred per cent. As would be obvious, he feels the procedure to be a bold one.

Brunn (13) reports five cases with one death. He holds great hope in the future for a lower mortality rate, and feels the cure by lobectomy should be ultimate good.

Graham (8) reports three lobectomies with one cure and two operative deaths.

Hedblom (30) performed four lobectomies with two deaths and two cures.

Ballon, Singer, Graham (8) collected two hundred twelve cases from the literature which they felt were fairly representative. They found that seventy two patients or thirty-four per cent have died apparently because of the operation and only ninety nine patients or forty seven per cent have showed satisfactory results. They conclude that if a patient submits to a lobectomy he runs a fifteen to twenty per cent risk of dying because of the operation, and if he survives the operation he has only about sixty five per cent chance of having a satisfactory result.

Lilienthol (31) operates in one or two stages, depending on degree of technical difficulties encountered at first stage and on patients reaction during its course. He uses intratracheal positive nitrous oxide and oxygen anesthesia. The
incision is made in the seventh or eighth interspace from just behind the costal cartilage to well behind the angle of the ribs. The wound edges are retracted and the lobe to be resected is separated and surrounded by gauze pack to prevent soiling. The pulmonary ligament is identified and divided and lung retracted, exposing the pedicle containing the bronchus, the branches of the bronchial artery and pulmonary artery and vein with lymphatics and enlarged glands. The pedicle is crushed and ligated in segments with heavy silk. The section is made an inch and a half distal to the ligature. After the pedicle has been almost divided a ligature is applied around the whole stump. All ligatures are left long and tied together and gently retracted to steady the mediastinum during the further course of the operation. The bronchial openings are disinfected with phenol and any oozing vessels ligated with catgut. The gauze pack is removed and the stump pulled through a hole in a twelve-inch square of rubber dam which is then gathered into the form of a bag with the stump in its depth, and iodoform gauze is packed around the stump inside of bag. The long silk ligatures from the stump are fastened to a safety pin lying across the outside of ribs in such a way that the ligatures exert a steady pull on the mediastinum during the first post-operative days. A stab drainage tube for closed drainage is used posteriorly. The skin incision is left open and packed with iodoform gauze.
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