

5-1-1933

## Bronchiectasis : its medical and surgical treatment

Norman C. Shoemaker  
*University of Nebraska Medical Center*

This manuscript is historical in nature and may not reflect current medical research and practice. Search [PubMed](#) for current research.

Follow this and additional works at: <https://digitalcommons.unmc.edu/mdtheses>

---

### Recommended Citation

Shoemaker, Norman C., "Bronchiectasis : its medical and surgical treatment" (1933). *MD Theses*. 292.  
<https://digitalcommons.unmc.edu/mdtheses/292>

This Thesis is brought to you for free and open access by the Special Collections at DigitalCommons@UNMC. It has been accepted for inclusion in MD Theses by an authorized administrator of DigitalCommons@UNMC. For more information, please contact [digitalcommons@unmc.edu](mailto:digitalcommons@unmc.edu).

BRONCHIECTASIS  
Its Medical and Surgical Treatment

Norman C. Shoemaker, B.Sc.

University of Nebraska

College of Medicine

College Library

1933

6

0

6

0

6

480530

## Table of Contents

1.	Definition -----	Page	1
2.	Preface -----		1
3.	Etiology -----		3
4.	Complications and Consequences -----		11
5.	Prognosis -----		13
6.	Diagnosis -----		17
7.	Treatment -----		21
	Prophylactic -----		22
	Medical or Non-operative -----		24
	Surgical or Operative -----		40
8.	Conclusion -----		93

PAGE ONE

DEFINITION

The term BRONCHIECTASIS or BRONCHIECTASIA merely means a dilated bronchus or dilated bronchi. It may affect the tube uniformly forming the cylindric type, or it may occur in irregular pockets (42).

Another authority states that bronchiectasis consists of dilatation of the bronchial tubes with inflammatory changes in the mucous membrane and thickening or thinning of the bronchial walls (83). These dilatations may be single or multiple, local or general (90).

PREFACE

In most cases of bronchiectasis which come for treatment, the symptoms are generally quite characteristic and classical. Most of these patients come late in the progress of the disease not only due to faulty diagnosis, perhaps on the part of their attending physician, but also to procrastination on the part of the patient, feeling that the condition will "clear up" as it may have done on previous occasions. Doctors

frequently diagnose this condition as a chronic bronchitis. Bronchiectasis is frequently the result of, or sequèl to, a chronic bronchitis ( 62 ), ( 96 ).

Besides the anatomical classification, bronchiectasis is either infected or non-infected, wet or dry, with symptoms or without, respectively. Whether congenital or acquired, bronchial dilatation is in itself harmless. It is only when the sacs are, or become infected, that they cause symptoms. Uninfected clinical cases are clinically silent; however, they are potential sources of trouble.(43). Hence it is well to bear in mind that all atelectatic cavities or dilatations that result from them, are potentially infected, and may at a future date become the wet, infected or symptomatic, grave type with its possible serious late sequellae(115).

Since it is the wet, infected, symptomatic type that causes the "present illness" to the patient, that type alone will be considered in this paper. The rules to be followed under "PROPHYLACTIC TREATMENT" should be heeded in this other type, however, as prophylaxis is today's best "cure" in medicine. Treatment should confine itself, in these latter cases, to eradicating foci which might serve to infect them ( 43 ).

ETIOLOGY

Bronchiectasis is caused by a multiplicity of things, the most prominent being the following:

Hasse and Rokitansky (62), (96) observed that bronchiectasis frequently followed upon chronic infective lesions such as bronchitis and tuberculosis; that when it followed upon the former, the lesion developed in a relatively shorter time; that late changes were always deep-seated, parenchymal, and that bronchiectasis which resulted from chronic bronchitis was of the cylindrical form. Engel (44) didn't concur with this latter remark. Weinberg (115) prefers to call this type a bronchitis, only a bronchiectasis in the strict sense of the definition. It is an early stage in the disease, and is more amenable to medical treatment. McCrae and Funk (80) have reported cases of apical bronchiectasis associated with tuberculosis. In the opinion of Rokitansky (95) bronchi near the surface and borders of the lung and those in contact with areas of emphysema are the ones most likely to become dilated. He also remarks that whatever may be the form under which bronchial dilations appear, bronchitis must be regarded as the primary cause.

An explanation of chronic bronchiectasis which follows acute respiratory disease in children, especially bronchopneumonia, is that the essential process is one of destruction of tissue, and not dilatation. The initial change which underlies the whole process occurs during the acute phase of the disease, and takes the form of a severe acute interstitial inflammation of the bronchial walls, going on to necrosis and suppuration. This causes the formation of a cavity by loss of tissue from the bronchus walls, 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 extension of the excavation, 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 be covered by bronchial epithelium 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. Accumulated secretions may tend to further dilate these cavities (81).

Tuberculosis is the common cause of pulmonary fibrosis in the adult, but in children most cases of pulmonary fibrosis are subsequent to the bronchopneumonia of measles, grippe, and



pertussis ( 9 ). Marchand ( 96 ) says that the bronchopneumonia of influenza, measles, pertussis, and typhoid fever predisposes to bronchiectasis. Hoffman ( 89 ) doesn't agree with this statement in that he feels that a special malignancy in these diseases is necessary to bring about such consequences. We ( 9 ) are inclined to agree with Hoffman. According to Lederer ( 72 ) the etiological factor in bronchiectasis is not measles or pertussis, but the associated bronchitis or pneumonia. The condition may develop during the course of years, and can be followed by reinfection, by disease of the tracheo-bronchial glands, and by pulmonary induration. Weinberg ( 115 ) believes the condition is caused by mucous plugs which cause obstruction, atelectasis, and eventually bronchiectasis.

Many fibrotic lungs are due to aspirated foreign bodies, and are associated with bronchiectasis. Quite a number of years ago Hamilton ( 58 ) made the following pregnant remark, "a fertile source of bronchiectasis in children is pulmonary collapse." (Atelectasis). It is only now that full cognizance of this remark is being taken. Post-operative massive atelectasis and patchy atelectasis play a part in the production of some cases of bronchiectasis ( 9 ).

Congenital bronchiectasis is met with in two main forms. These are the so-called universal and telangiectatic bronchiectases. They often fail to produce symptoms although cavities the size of a hen's egg may be present in the lungs of infants a few months old.

In the telangiectatic form, the lung or part of it is found to be converted into a mass of cysts lined with high epithelium. They may be quite empty and so suggest a pneumothorax pocket. Such cyst-like dilatations may rupture and are then not infrequently the cause of spontaneous pneumothorax. The cysts may fail to communicate with bronchi. This type may be compared to a congenital cystic kidney and the process considered to be the result of hydropic dilatation of a main bronchus and its branches.

Universal bronchiectasis 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. ( 9 )

According to Heuter (67 ) many of the so-called cases of congenital bronchiectasis are due to developmental anomalies

in the bronchial tubes. Brauer and Wiese(20,120)have repeatedly expressed the thought that the sum total of all anomalies which are met with in the bronchial tree play an insignificant role in the etiology of bronchiectasis.

- Fröhwald ( 50 ) reported an instance of intercostal lung hernia which was associated with fetal bronchiectasis.

Intrauterine conditions such as premature separation of the placenta, compression of the umbilical cord, increased intracranial pressure, also changes in the mother's circulation which affect the carbon dioxide of the mother's blood, or a drop in blood-pressure, or an internal hemorrhage, may all affect the placental circulation. This causes the atelectatic type of bronchiectasis which is to be considered as that widening of the bronchi which occurs in parts of the lungs which have remained collapsed throughout life. ( 9 )

The thoracic cage may be quite normal in all forms of bronchiectasis. However, softening of the ribs, weakness, of the muscular elements, retention of secretion, in other words, weakening of respiratory efforts, may in some cases lead to bronchiectasis. The rachitic thorax perhaps predisposes to bronchiectasis in that when such children contract pneumonia, atelactatic areas are more likely to exist and become bronchiectatic. ( 9 ).

A solitary or multiple chronic lung abscess may be associated with bronchiectasis. When the former is treated early, then the bronchiectasis usually becomes healed. If the abscess does not heal, or if it is neglected for many months, then the associated bronchiectasis may become very obstinate (9).

With the exception of enlarged mediastinal glands, intrathoracic swellings are seldom responsible for bronchial dilatations in children.

A broncho-plural fistula which persists for an appreciable length of time may result in the production of bronchial dilatations in the adjacent lung tissue (9).

The clinical picture of pneumoconiosis may be that of bronchiectasis. Norris and Landis (86) are of the opinion that the prolonged exposure to inorganic dust as anthracosis, chalicosis, and silicosis in miners and potters, is one of the most frequent causes of bronchiectasis.

In his latest work Smith (107) concluded the following: "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 anerobic organisms. This group comprises *T. macrodentium*, *T. microdentium*, *S. vincenti*, *S. buccalis*, fusiform bacilli, vibrios and cocci, the same organisms that are found in pyorrhea alveolaris, Vincent's angina, pulmonary abscess, and pulmonary gangrene. Smith observed these micro-organisms in the sputum of 49 of 60 patients

proved to have bronchiectasis by the lipiodol test. And certain it is, that some patients with bronchiectasis whose sputum contained spirochetes and fusiform bacilli, responded remarkably following the use of neo-salversan. The amount of odor rather than the amount of secretion was reduced.

Fungus disease of the lung is occasionally associated with bronchiectasis. Pulmonary sporotrichosis has been reported by Forbus ( 49), Singer ( 102), and others. Singer and Ballou ( 106), have referred to streptothrix and bronchiectasis. Blastomycosis and actinomycosis are occasionally responsible for dilatation of the bronchi.

Mediastinal pleurisy is frequently associated with bronchiectasis and is undoubtedly due to primary atelectasis in some instances. Any evidence of mediastinal thickening, particularly in a child, is very suggestive of paravertebral bronchiectasis; only a negative lipiodol injection permits one to exclude its presence in such cases. Mediastinal pleurisy usually results from paravertebral bronchiectasis ( 9 ).

In the lungs of dogs and men affected by "gas warfare" the chief etiological factor in the formation was the chronic infection with weakening of the bronchial wall aided by obstruction resulting from the organizing bronchiolitis caused by the irritant gasses ( 9 ). Hoffman ( 69 ) stated that the bronchi also lose some of their resistance as a result of catarrh.

Stenosis of bronchi is usually caused by compression from tumor without the bronchi, growth in the wall, as in syphilis, or with benign or malignant tumors---with the associated cough, forced inspirations, and infection. Bronchial stones with stricture may be a cause.

The factors at play in bronchiectasis in the adult are (I) Intrabronchial (a) foreign bodies and mucous plugs which cause bronchial stenosis (b) bronchial stones with stricture (c) bronchial tumors, benign or malignant, with cough, forced inspiration, and infection.

(II) Bronchial and mucous membrane changes as in (a) atrophy, proliferation, metaplasia, or ulcer formation with healing by scar (b) bronchitis and catarrh (c) loss of elastic tissue (d) changes in muscle and cartilage (e) hypersecretion due to over stimulation of glands, or loss of contractability and sensibility (f) strictures (syphilis) (g) vascular changes found in fusospirochetal disease.

(III) Peribronchial (a) diseased and enlarged glands (b) adhesions (mediastinal) (c) tumors and enlarged intrathoracic organs (aneurysms).

(IV) Pulmonary (a) pneumonia (broncho, lobar, interstitial) (b) pulmonary fibrosis (c) tuberculosis, abscess of lung, tumor, anthracosis, potter's lung (d) fungus disease and sporotrichosis (e) emphysema.

(V) Pleural (a) bronchopleural fistula (b) adhesions (c) effusions.

(VI) Referable to thoracic cage (a) rickets--predisposition to respiratory disease (b) weakening of thoracic form. (9 )

#### COMPLICATIONS AND CONSEQUENCES

That bronchiectasis is a frequent consequence of tumor of the lung is well known. But few instances of tumor formation in a bronchiectatic dilatation have, however, been recorded. Siegmund ( 101 ) has described three instances, and in two of these cases bronchiectasis was undoubtedly primary.

Associated changes in the lung are extensive fibrosis, and in extreme cases cirrhosis of lung, emphysema, gangrene of the lung as from gangrenous dilated bronchus, and septic bronchopneumonia due to inhalation of septic material which may produce death (23 ).

Changes in the other organs are dilatation of the right heart due to obstructed circulation in the lungs, if extensive fibroid changes or emphysema are present. In the surgical treatment of bronchiectasis, Hedbloom (65 ) believes

the post-operative mortality is due to myocarditis and nephritis, from chronic toxic absorption, and hypertrophy and dilatation of the right heart, from increased pulmonary venous pressure. Injury to these vital organs is probably always greater than clinical manifestations would indicate. Amyloid changes in the liver and kidneys are seen at autopsy. Abscess of the brain is a not infrequent cause of death (83). The association of brain abscess and pulmonary disease has long been known, but it is still difficult to explain the mechanism responsible for it. That the infection occurs in the respiratory tract and brain simultaneously is of course possible, but what is more likely, is that the brain abscess is a metastasis from the pulmonic condition (9).

Bronchiectasis may be complicated by an empyema which is usually an encysted one. Most patients are first observed when the lesion is chronic. When the empyema is associated with mild bronchiectasis, then drainage of the former may affect a symptomatic cure. The first procedure should always be the treatment of empyema, but in not a few instances, it is desirable to treat the bronchiectasis as well.

The changes in the extremities to be noted are (a) clubbing of fingers and toes due to increase in soft tissue about terminal phalanges (b) an increase in the size of bones of the forearm and leg due to proliferation of the osseous tissue, seen in the more severe cases (c) bony exos-



toses which may form about the joints (d) effusion into a joint (e) joint pains associated with the same process due to congestion and toxemia. This type of arthritis is called hypertrophic pulmonary osteo-arthropathy.

The consequences and results of each individual method of treatment will be discussed when those methods are considered under the Treatment of bronchiectasis.

#### PROGNOSIS

The prognosis in every case of bronchiectasis must be guarded. The disease is chronic yet not incompatible with long life. (83), (13). If the bronchiectasis be a sequel to measles, pertussis, influenza, or exposure to irritant gases, the patient may be subjected to bronchitis during the winter months. Death is usually due to (a) failing compensation (b) "internal drainage" (45) (c) bronchopneumonia (d) cerebral abscess (e) generalized sepsis (f) amyloid changes in the liver and kidneys with gastro-intestinal symptoms (g) or as the result of operative procedures (13), (83). Amyloid disease is a serious late complication occurring years after the onset of bronchiectasis. It is related to the bronchiectasis only because of long continued suppuration,

and in this respect is no different from the amyloid disease which is known to follow chronic suppuration in other organs. Among other things, the presence of much albumen in the urine, and a palpable liver, are suggestive. Anemia and cachexia are marked in generalized amyloidosis. This condition should be diagnosed before treatment is instituted as it usually is a contraindication to the performance of any radical operation. The prognosis should always be guarded when amyloid disease is evident (13).

Findlay and Graham, S. (46) in 1931 concluded that in childhood the prognosis of bronchiectasis is grave, as the condition steadily gets worse and leads to fatal termination. The age of the onset of the bronchiectasis would seem to influence the course of events. The recovery is more probable in the examples which develop during later childhood.

In the case of the child and of the adult with untreated or inadequately treated bronchiectasis which has been demonstrated by lipiodol, and which is associated with definite signs and symptoms, up to the present time it doesn't seem that the bronchiectasis disappears very often. More important, however, is the fact that at the present time we have no right to state that the lesion need progress in every case, as sacular dilatations of the congenital variety are frequently first observed in adult or middle-aged indi-

viduals which implies that bronchial dilatations may be present for many years without attracting attention clinically. It is also a fact that we frequently observe advanced bronchiectasis of the acquired type in young children (13). This disproportion between the signs and symptoms and the dilatations in some cases may be striking. Bronchiectasis may develop very rapidly. We have seen it develop in less than three months in an infant who had aspirated a peanut. In children with cystic disease of the lung, there is often an associated condition of bronchiectasis entirely apart from the cysts. When the cysts are large, then the bronchiectasis present is usually of the acquired type. The outcome in such cases is frequently unfavorable even though the cysts fail to become ruptured or infected, for the bronchiectasis in such cases is usually associated with considerable pulmonary fibrosis, with chronic pneumonia, and abscess formation. On the other hand, the outcome of congenital saccular bronchiectasis called by some authors, cystic bronchiectasis, seems not nearly so unfavorable although we still require more information about such cases. (13).

Some cases of foreign body bronchiectasis in children may have a favorable outcome if the foreign body is removed early; but if it has been allowed to remain until irreparable damage has been done to the lung, then the out-

come, even after the withdrawal of the foreign body, may be most unfavorable.

Perhaps the most unfavorable type of bronchiectasis in a child is that which is clearly manifested by the displacement of mediastinal contents to the affected side. Those types of bronchiectasis in children which are associated with much fibrosis, and with progressive displacement of the mediastinal contents to the affected side, usually end fatally within a few years. They are frequently due to a foreign body.

We (13) do not wish to imply that it is always possible to separate out the various types of bronchiectasis in the manner indicated above. It would likewise be unwise to conclude that the outcome suggested is always the same in any given type of case.

What has been said about bronchiectasis in the child also holds true for bronchiectasis in the adult. It is frequently impossible to prognosticate just how long a patient with a given type of bronchiectasis will live if untreated. Certainly there are cases in which the duration of the disease has been known to exceed well over fifteen years. (13).

DIAGNOSIS

The diagnosis of bronchiectasis should include (a) the determination of what lobes are involved (b) the size and distribution of dilatations (c) the degree of fibrosis as evidenced by atelectasis and shift of mediastinal contents (d) whether or not the lesion is tuberculous (e) and see if such complicating factors as foreign body, pulmonary abscess, bronchial stenosis, carcinoma, empyema, brain abscess, or amyloid disease, are present.

Diagnosis is attained by means of (a) clinical history (b) physical findings and symptoms (c) laboratory findings (d) Roentgen-ray findings including fluorescopy (e) bronchography (f) and bronchoscopy.

The clinical history usually shows some involvement of the accessory nasal sinuses (92), middle ear infections, or infected tonsils and teeth. A chronic productive cough with foul smelling sputum and tending to show remissions is characteristic of bronchiectasis (13).

Of the physical findings, clubbing of the fingers and toes, and a bulbous nose may be determined by inspection. Hypertrophic pulmonary osteo-arthritis may be present (83). Palpation shows nothing distinctive. There may be a

retraction of the chest on the infected side, and it may draw neighboring structures out of place. Percussion, producing tympany due to dilatation, at the angle of the scapula posteriorly means bronchiectasis; at the apex it is apt to be confused with a tuberculous cavity. Metallic or resonating rales over the affected area, similar to those of pulmonary excavation may be auscultated.

The patient has a chronic productive cough, and fetid sputum in amounts up to 1500 cc. in twenty-four hours may be coughed up. This amount is uncommon, however, and is not present if bronchiectasis is in the upper lobes. The characteristic sputum is greenish or grayish with an offensive odor. It is thinner than that of chronic bronchitis and separates on standing, into three layers of pus, serum and frothy mucous. It contains great numbers of miscellaneous bacteria. The sputum may be blood-streaked due to bleeding granulations. A feature of cases with a single large cavity is its periodic emptying, usually upon arising in the morning; in other cases no periodicity is evident (113). The odor of the sputum is due to fatty acids, ammonium carbonate, sulphides, indol, and other products of putrefaction and autolysis. Ferments are also present. If the lung is adherent to the diaphragm there may be a shortness of breath.

Any associated pain is usually due to pleurisy. Frequently the patient may enjoy fairly good health and freedom from constitutional symptoms, although attacks of fever, sweats, and chills, due to small patches of bronchopneumonia, are the rule in the later stages when the health fails (13).

Thorpe, Jr. (112) can't help pointing out the necessity of early diagnosis as an aid to efficient treatment. He even says that if all cases suspected of having suppurative bronchitis were early treated, (bronchoscopically), and not filled with worthless cough mixtures, bronchiectasis would actually be a rarity.

One must rule out tuberculosis, lung abscess, foreign body, loculated empyema and gangrene of the lung (33), (13).

Davis (37) points out that the classical picture of fetid sputum, clubbed fingers, emaciation, etc., is surely the final stage of this devastating disease, and if it be allowed to reach this stage, little improvement can be expected from any therapeutic agents.

Roentgen-ray findings including fluorescopy, in themselves, may not show anything characteristic of bronchiectasis. This method has largely been replaced by bronchography.

Bronchography, or the Roentgen-ray examination of the bronchial tree after the bronchus has been injected with opaque material, as lipiodol, is absolutely diagnostic of bronchiectasis. Various types have been classified, and more than one type may be present in the same lung (6). Bronchography is used to verify the presence of dilatations which ordinary x-ray films may suggest. Lipiodol has replaced the diagnostic pneumothorax in bronchiectasis.

Above classification of bronchiectasis by Ballon and Ballon (6) based on bronchoscopic injections of lipiodol, represents types most commonly encountered. Some of them in all probability represent various degrees of bronchiectasis. More than one type may be present in the same lung.



Bronchoscopy is especially valuable in ruling out (a) foreignbody (b) neoplasm and (c) bronchial stenosis. One can observe which bronchi are discharging the pus. A more complete lipiodol injection is possible as the secretions can be aspirated and granulations may be removed previous to the injection. The lipiodol can be directed to the desired area thus giving a more exact interpretation of the injection picture. It is possible to obtain uncontaminated cultures from the pus pockets by this method. This is of value in vaccine therapy when autogenous vaccines are desirable.

#### TREATMENT

The treatment of bronchiectasis may be divided into three groups (a) prophylactic (b) medical or non-operative and (c) surgical or operative.

A cure can only be considered when the diseased portion of the lung has been removed or destroyed. Bronchiectasis is characterized by remissions, and striking early improvement under any regime, may later be nullified. More than symptomatic cure can hardly be expected in most cases. On some occasions relief from symptoms is apparently all that is necessary. Little evidence has been forthcoming so far

to indicate that spontaneous cures occur very frequently (14).

Treatment depends on (a) the age of the patient (b) the mode of origin, and (c) the nature of the lesion (d) and the presence or absence of local or general complications.

#### PROPHYLACTIC TREATMENT

Up to the present time it must be admitted that there is no prophylactic measure which carries with it any assurance that its employment will avoid the development of bronchiectasis. It is obvious that we are more concerned with the condition in children and young adults than we are in older people. The bronchopneumonia of pertussis and the exanthemata should be treated with respect and great care should be exercised during the period of convalescence. Catarrhal lesions of the upper and lower respiratory tracts should be prevented from becoming chronic whenever possible. Respiratory conditions associated with profuse expectoration should, in the absence of any contraindications, be treated by postural drainage. In the past, attention has been directed to the treatment of the upper respiratory tract only after bronchiectasis has become definitely established. We have no right to

assume that the treatment of nasal sinus infections, in the absence of bronchiectasis, will prevent the subsequent development of bronchial dilatations. It should be remembered, too, that untreated lung abscesses are known to become associated with bronchiectasis. Perhaps some of those measures which are now being employed to combat the development of post-operative pulmonary complications, such as atelectasis, may diminish the frequency of bronchiectasis slightly. It is true that the early correction of such known bronchial factors as foreign body, and stricture can avoid the occurrence of the disease (14).

As bronchiectasis may follow the aspiration of infected fluid during tonsillectomy and other operations about the mouth, the avoidance of general deep anesthesia and the substitution of local anesthesia as far as possible, and the use of suction devices to prevent the aspirations of pharyngeal secretions into the trachea, are important. Foreign bodies should early be localized and removed through a broncho scope (4).

In modern medicine, prophylactic treatment is the ideal "cure". Bronchiectasis is no exception in this respect. Riviere, in 1926, strongly advised "anticipatory" treatment or prevention in bronchiectasis (93).

## TREATMENT

## MEDICAL OR NON-OPERATIVE

Of the non-operative or medical procedures employed in the treatment of bronchiectasis we have the following to consider: (a) rest (b) diet (c) climate (d) postural drainage (e) thirst cure (f) heliotherapy (g) intravenous therapy--neosalversan (h) direct intratracheal application of drugs by syringe or spray (i) treatment of nasal sinuses and other foci of infection (j) inhalation of superheated air with a mixture of suitable drugs, and (k) vaccine therapy.

Symptomatic treatment as rest, good food, fresh air, exercise, and sunlight, all properly graduated, to Marvin (79), Smith (108), and Boyd (18) has been encouraging, as the patients showed increased weight and appetite, and enthusiasm to continue treatment. Along with the treatment of foci of infection, as care of the teeth, tonsils, sinuses, otitis media infections, and prostates, etc., a decided improvement was noticed in some cases. Whitaker (116) believes similar treatment to be of value. He also prescribes tonics, violet ray, and cod liver oil. Singer and Graham (105), in 1929 emphasized the importance of examination and treatment of nasal sinuses in bronchiectasis, and they found that after proper

treatment of badly infected nasal sinuses, the amount of purulent sputum is greatly diminished. Quinn and Meyer (92) showed that the aspiration of iodized oil into the lung from the nasal fossa while one is asleep, occurs with apparent ease, and not infrequently, the quantity aspirated is surprisingly large. Since the aspiration of an oily fluid from the nose is so easy, it seems logical to assume that aspiration of infected material, as pus, may also be simple. In view of this circumstance, it is felt that aspiration is probably the most important explanatory factor for the frequent concomitance of bronchiectasis and sinusitis. In a series of 38 patients with bronchiectasis, 57.9% were found to have coexistent sinusitis, and the majority of the patients had no symptoms of sinusitis. One may compare the respiratory tract to the urinary tract in which cystitis follows renal infection. The treatment is, of course, to remove the source of the infection, then treat the sequelae (14). Bloesser (43) likewise believes that upper respiratory tract infection should be treated, especially the sinuses.

Rest in bed usually gives relief, even with marked diminution in the quantity of sputum, but never any lasting improvement after the patient gets up (14). Rest in bed, however, tends to build up the general health, thus should always be used before other measures.

All forms of diets including those rich in vitamins have been employed. None of them have given worthwhile results (14). Babcock recommends over-feeding. (4 ).

There is little evidence at the present time to indicate that a change in climate is of any definite value, although it is advisable for a patient with bronchiectasis to avoid an atmosphere which contains irritative gases (14). To some doctors, this procedure should be a panacea for bronchiectatic patients! However, to live out of doors, get plenty of fresh air and sunshine should, along with a good diet and rest, tend to build up the general resistance.

Medical treatment as such, is unsatisfactory in that it can not cure the condition permanently, although at times it may give temporary symptomatic relief. Burrell (27) uses creosote in capsules of minims  $\overline{ij}$  to doses of dram  $\overline{j}$  daily. Whitaker (116) recommends the use of five drops of creosote t.i.d. The production of adequate drainage is still the most effective means we have of treating fetor. Some patients do feel better following the use of expectorants, but no one substance is completely effective in the treatment of fetor. Osler (90) says that drugs are indicated to (a) reduce the amount of sputum (b) facilitate its expulsion (c) and to remove the foul odor of the sputum. He recommends oil of cloves in doses of minims  $\overline{ij}$  to minims  $\overline{ij}$  with benefit, while

Hare recommends oil of cloves in olive oil by hypo. Osler says intratracheal injections of iodoform in olive oil (2 to

10% emulsion) or Rx	Menthol	10
	Guaicacol	2
	Olive oil	88

in doses of dram  $\bar{i}$  into the trachea b.i.d. may be employed with good results. Ammonium chloride thins out secretions, thus making coughing easier, and 2% monochlorophenol used in an atomizer relieves upper respiratory infection (83). Compound tincture of benzoin inhalations relieve bronchial tree irritation, and creosote is supposed to be excreted through the lung exerting an antiseptic effect there. Burrell (27) and Rivière (93) recommend creosote inhalations in the creosote chamber, assisted by drugs and reinforced, if necessary, by bronchoscopic treatment, and postural drainage by any method that is practical that will give the patient relief from his symptoms. General hygienic advice is also given. To Marvin (79), inhalations have proven ineffective.

The creosote vapor bath first excites coughing to empty the cavities, then it has a direct disinfecting effect due to the fumes. The eyes must be protected by well-fitting goggles or watch crystals attached with flexible collodium, and the nose stuffed with cotton-wool. Then 20 to 30 drops of creosote are placed in an open dish and heated by an alcohol

lamp. It is employed for a few minutes to a half an hour at first, later from 1 to 2 hours as the individual becomes more accustomed to the process (90). According to Ballou, Singer and Graham, (14) the use of inhalations of superheated air with a mixture of suitable drugs as a means of treating bronchiectasis, has been discarded. Also contrary to the belief of Burrell (27) they believe that heliotherapy, or the use of sunlight, quartz light, etc., has no particular value in the treatment of bronchiectasis. They further say that it is more or less agreed that vaccine therapy is of no particular value in the treatment of bronchiectasis. Sargent (98) writes that he has seen no good from the use of vaccines. This is also Weinberg's belief (115). Jacquet, Roquejoffre, and Alavoine (70) reported that the bronchorrhea and arthritis of a patient with bronchiectasis and arthritis had improved following vaccine therapy. Thorpe (112) believes that autogenous vaccines prepared from endoscopic drainage should certainly be tried in advanced cases. Boyd (18) believes early cases with proper eradication of foci of infection plus autogenous vaccine will produce a cure. Whitaker (116) believes autogenous vaccines are of value and should be given. Marvin (79) believes vaccine treatment started with 0.1 cc. dose and increased by 0.1 cc. semiweekly up to 1.00 cc. at the end of five weeks and given only once a week thereafter, to be of



benefit, although autogenous vaccines from bronchoscopic drainage are probably better. He also believes that drugs which inhibit coughing should be avoided if possible.

It was once thought that a reduction in the fluid intake might result in a reduction in the amount of expectoration, since the latter in bronchiectasis, is to a very large extent composed of water. This form of treatment has been given a fair trial and has been shown to be of little or no value (14).

Singer and Graham (105) in 1929 mentioned that they examined the sputum of bronchiectatic patients routinely for Koch's bacillus and spirochetal organisms. In the presence of spirochetes they found no startling benefits following the use of arsenicals even when the sputum contained many spirochetes. In certain cases they found it of benefit however. Smith (107) is certain that some patients with bronchiectasis whose sputum contained spirochetes and fusiform bacilli responded remarkably following the exhibition of neo-salversan. The amount of odor rather than the amount of secretion is reduced. Alexander and Buckingham (1), (26) find neo-salversan intravenously to be of value in early cases.

At the present time, neo-arsphenamine is perhaps the only drug given intravenously, although colloidal silver found favor for a time. It is used when the sputum contains

many fusiform bacilli and spirochetes. The therapeutic results are sometimes striking. This is usually the case when there is adequate drainage, and little retention of secretions. Unfortunately, many patients with bronchiectasis whose sputum contains the above-mentioned organisms, fail to respond to this form of treatment. We (14) have never observed a patient with definite bronchiectasis as demonstrated by lipiodol, in whom by the use of neo-salversan alone, there was accomplished either a permanent subsidence of the symptoms or a diminution in the size of the bronchial dilatation. This form of treatment may be helpful, however, in combination with other forms of treatment.

Postural drainage is most valuable, and may be carried out continuously or intermittently. The continuous postural drainages allows the patient to carry on this form of treatment day and night, and is carried out by elevating the foot of the bed. Various devices have been recommended. Singer has recently devised a bed which can be used for continuous or intermittent postural drainage. A modified Quincke tilting table for postural drainage may be employed. Many patients suffering from mild bronchiectasis require no other form of treatment. They are able to go about their work if they empty their dilatations early in the morning. Some are required to repeat this postural drainage several times daily.

Intermittent postural drainage should never exceed two or three minutes at a time, and may be carried out with the patient lying either on his abdomen or on his back. Postural drainage should always be given a fair trial before any other form of treatment is suggested. It may be supplemented with profit by bronchoscopic aspirations in certain cases (14).

Marvin (79) starts postural drainage at the earliest opportunity, two or three times daily, or every hour in the more severe cases. The postural drainage is attained in twenty to thirty minutes by the adjustable table method, by which the patient is placed on a bed-like frame which is so constructed that it may revolve on a horizontal axis passing through its center allowing the patient's body to be placed at any desired angle. He prefers the more effective jackknife drainage method, which requires three to five minutes and has the advantage of mechanically compressing the lower thorax. In this method, the body is bent over a horizontal bar, like a jackknife, the head resting on an appropriate round of a ladder-like projection from the base of the bar support, with the legs suspended in the air, without support. However, he believes bronchoscopic drainage to be better than postural drainage, especially when the secretions have become tenacious and crusted, and require softening by injection of some liquid before suction can remove them.

Singer and Graham (105) use postural drainage, with artificial pneumothorax when few or no adhesions are present, and it has given them good results. They believe the lower lobe becomes elevated and that they get better drainage. Eloesser (43) believes in previous medical treatment, rest, postural drainage, and a dry, warm climate as palliative measures, in the treatment of bronchiectasis. Burrell (27) and Boyd (18) use postural drainage along with medical treatment and other measures with good results. Thorpe (112) uses postural drainage, breathing exercises, plenty of nourishing food, etc., supplementing bronchoscopic drainage. Alexander and Buckingham (1), (26) believe in postural drainage associated with elimination of mouth and sinus infection, in conjunction with other measures. Lilienthal (73) believes in preliminary postural drainage before he operates (—). Riviere (93) favors postural drainage along with medical treatment before surgery is instituted. Shenstone (99) utilizes postural drainage before operation in every case to prevent "internal drainage." (See (45)).

For years many drugs have been injected into the bronchial tree not only in the treatment of bronchitis and tuberculosis, but also bronchiectasis. At the present time lipiodol is frequently used. The 40% iodine in lipiodol is intimately bound up with poppy seed oil. Lipiodol has no an-

tiseptic properties, however, quantities of the oil on culture plates exposed to air for several months showed no evidence of degeneration, and no colonies of bacteria or fungi were observed. Ballon ( 11) showed experimentally that lipiodol may remain unchanged in normal lungs for weeks or months. There is no lymphatic distention and hence no subsequent infiltration or fibrosis. Mononuclear cells engulfed with oil are not infrequently to be seen in the alveoli. Loeb and Michand (74) and others have shown that tuberculous tissue, and all inflammatory foci, have a high affinity for iodine, and store it in abnormally high amounts. In experiments with dogs, Curtis, Cole and Ballon, (36) showed that iodine is rapidly absorbed from the intra-pulmonary lipiodol, since the blood iodine rises from 3.5 to 6.0 times the normal control in 2.5 hours. Similar rises occur after oral administrations of iodine preparations. It is hardly necessary to mention that many patients swallow some of the lipiodol during the course of the injection.

Contraindications are (a) acute active tuberculosis (b) early advanced general pulmonary suppuration (c) angina pectoris (d) aneurysms (e) hemoptysis (f) cardiac decompensation, and (g) any acute inflammatory involvement of the upper respiratory tract.

methods  
Mainzer (75) describes four employed in the injection of oil (a) Supraglottic, in which the warmed oil is allowed to flow through the glottis into the trachea. Turner (114) employs this method because of its simplicity and a less likelihood of carrying infection from the mouth to the lungs. He believes the oil will remain in the bronchiectatic cavities from 1 to 6 weeks, depending on the size of cavity, and size and position of the bronchus of which it is a localized dilatation. The iodine from the slowly disintegrating oil has its effect on the wall of the pocket during its stay in the lesion. The pockets are reinjected as often as they appear empty on fluorescopic examination. When a case is first injected it should be fluorescoped every week afterwards, until the length of time required for absorption and elimination is observed. Every case is different in this respect and should be so considered. (b) Transglottic, which consists of introducing a flexible rubber catheter through the larynx and injecting warmed oil into the trachea and respiratory passages. (c) Subglottic, in which a hollow curved needle is passed through the cricothyroid membrane into the lumen of the trachea after first anesthetizing the skin and soft tissues. This method is employed mostly by the French. (d) Bronchoscopic, which he uses and believes is the most advantageous, because this method allows the secretion present 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 endoscopy would detect it at once.

The mucous membrane of the posterior pharynx is anesthetized with 10% cocaine. The patient is placed in a partial upright position, and instructed to breath<sup>ce</sup> 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 5% cocaine is passed through the bronchoscope and the lining 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 all can thus be had. The bronchoscope is now withdrawn following the injection of oil, and the patient taken to the X-Ray room where the oil outlines with precision

the size of the cavity formation. Deuss (40) further describes an intratracheal method of lipiodol injection in which a two barrel catheter is passed directly into the trachea, one barrel through which the oil is passed, the other through which the patient breathes. He personally uses Ochsner's technique which is as follows: it consists of anesthetizing the anterior pillars of the pharynx which abolishes the swallowing reflex, hence swallowing is impossible, and the larynx, which normally rises during deglutition to lie beneath the epiglottis and the base of the tongue, remains immovable. The tongue is pulled forward and 3 to 5 cc. of 2% novocaine is slowly poured on it and allowed to flow into the pharynx, whence it will be passively aspirated. This generally induces coughing and produces expectoration of sputum. This may be allayed by morphine sulphate gr. 1/6 or 1/4 given by hypo 15 minutes previous to the procedure. In addition to the diagnostic value of iodized oils, he finds repeated instillations of them an effective means of therapy, probably in that the heavy, stagnant secretions are emulsified and more easily expectorated. The iodine itself may have some benefit on the body. He used Iodochloral (peanut oil base with 27.5% iodine and 7.5% chlorine) for radiography and therapy in his cases and believes that unless definite contraindications exist, bronchiectatic patients should be given the benefit of these treatments.



The iodized oil has a therapeutic effect in bronchiectasis as it (a) lessens the amount of expectoration (b) reduces the number of bacteria in the sputum, and (c) lessens the toxic symptoms and reduces the size of dilatation.

Ochsner ( 89) treated 112 patients with bronchiectasis with repeated injections of iodized oil into the tracheobronchial tree. The largest number of fillings received by any one patient did not exceed 16. 32% got complete relief of all symptoms, 3% got symptomatic relief and th<sup>e</sup> dilatations apparently disappeared. In 36% symptomatic relief was obtained, but following an acute upper respiratory infection, there was a return of some cough with a slight amount of sputum. Improvement was marked in the remaining cases.

Ochsner (88) had a case in which the infection within the bronchiectatic cavities served as a focus of infection, causing pain in the shoulders, knees, and occasional attacks of gastro-intestinal upsets. As a result of the infection, the patient lost 45 pounds in weight within a years time, and was practically incapacitated. He received 19 injections of iodized oil, at intervals of 5 days to 4 weeks, and was symptomatically relieved, gained all but 8 pounds of his original weight, and is able to carry on all of his duties as a busy executive. The dilatations of the bronchioles were

expectorated material, and an alleviation of the cough. One patient developed signs of toxic goiter after several injections. He showed, finally, exophthalmos, tremor, and enlargement of the thyroid gland. He wasn't given any more treatments and made a good recovery, except for a slight exophthalmos. Swann finds it offers more in the treatment of bronchiectasis than any other thing he has tried, except change of climate.

Eloesser ( 43) says he has rarely seen a therapeutic effect from lipiodol injection, although he had never seen harm from it, barring an iodide rash after it had been swallowed into the stomach.

Singer (103) treated some patients with weekly refills of lipiodol for almost two years, and none of his patients showed the striking results just referred to. The only visible untoward effect seems to be the drowning of certain portions of the lung. We (14) have never observed the disappearance of dilatations and at the present time, can not admit that the use of lipiodol has resulted in any lasting clinical cures of any of our patients with true bronchiectasis. We feel, too, that the observations must exceed several years.

not affected by this therapy. He stresses the fact that this type of therapy is merely palliative, but that it controls the infection within the bronchioles and that the symptoms are the result of the infection, hence when the infection is controlled, the patients become symptomatically well.

Steinh (109) in a report of 19 cases treated with lipiodol, found complete relief from cough and expectoration in 32% of the cases in which the bronchiectasis was not extreme. In 46% of the cases where complete relief from symptoms wasn't affected, both subjective and objective improvement resulted. No improvement was noted in the other four cases.

Ballou ( 7 ) is of the opinion that the beneficial results of lipiodol injections are due practically entirely to the fact that lipiodol can displace the sputum. The distribution of the dilatations remain unchanged following the therapeutic administration of lipiodol, and at the present time it seems to be most helpful in the less advanced forms of cylindrical bronchiectasis.

In a small series of cases of lipiodol injection by the intratracheal method by Swann (111), he gave a percentage of 63.6 markedly improved, 18.2 questionably improved and 18.2 with no improvement. There is always a soothing effect of the oil for one or two days, a marked reduction in the quantity of

TREATMENT

SURGICAL OR OPERATIVE

Of the operative procedures in bronchiectasis we must consider (a) bronchoscopic drainage (b) pneumothorax (c) oleothorax (d) compression by means of pack and plombage (e) thoracoplasty (f) phrenicectomy (g) ligation of pulmonary artery (h) pneumotomy (i) cautory pneumectomy, and (j) lobectomy.

The value of the bronchoscope in the treatment of foreign body bronchiectasis and in certain cases which are due to partial bronchial stenosis is obvious. The chief object in the treatment of most cases of bronchiectasis is to promote drainage. Neither postural drainage nor bronchoscopy will, in the strict sense of the term, cure any patients with bronchiectasis, but they can cause an arrest of symptoms in certain cases. The important consideration is not the dilatation, but whether it is wet or dry. The value of bronchoscopy lies, therefore, in removing or treating local causes (foreign bodies, bronchial stones, or dilating strictures, etc.), in promoting drainage, and in attempting to prevent the progression of the disease (spilling over of secretion). Perhaps its greatest value may some day be in the treatment of those conditions which may lead to bronchiectasis. Clerf ( 31 ) and

Ballou ( 8 ) believe that the milder forms of bronchiectasis associated with nasal sinus suppuration should be treated bronchoscopically. It is admitted from the start that no method such as bronchoscopy would ever cure a patient with advanced bronchiectasis, but it is equally certain that many with advanced bronchiectasis may be rendered fit members of society (14). Shenstone (99) does not use the bronchoscope at all. Lilienthal (73) believes in preliminary lavage of the bronchiectatic cavities before operation, if the patient is accustomed to the procedure and it is not too fatiguing. Clerf (31) and Harrington (60) believe bronchoscopic examinations should be made in all cases in which an operation is contemplated (unless there is some definite contraindication), so as to rule out possible endobronchial lesions as carcinoma of the bronchus, or foreign body.

In bilateral bronchiectasis occurring in adults, bronchoscopy is an aid to the internist and its benefits are temporary; in children, bronchoscopy combined with other appropriate measures is often followed by excellent results. Burrell (27) and Whitaker (116) use the bronchoscope for the comfort of the patient. Burrell believes the aspirations may eventually dry up the secretions and give permanent improvement. Rivière (93) and Smith (108) use the bronchoscope along with medical treatment before surgery is attempted. Alexander and

Buckingham (26), and Boyd (18) believe in the use of the bronchoscope before more serious measures are contemplated. Thorpe believes that if all cases suspected of having suppurative bronchitis were bronchoscopically treated and not filled with worthless cough mixtures, bronchiectasis would actually be a rarity. A comprehensive program utilizing postural drainage, breathing exercises, cod liver oil, fresh air, etc., between treatments should be planned for every case, and no other remedy seems to be of any use. (112).

Martin (78) examined and treated sixty-one cases of bronchiectasis by carry out as complete aspiration as possible, using an aspirating bronchoscope with a continuous suction. A two-way cannula, one tube being for continuous suction is passed through into the cavity which is detected, aspirated, and dried as far as possible. Through the second tube of the two-way cannula, weak boric acid solution is pumped into the cavity which is washed and cleaned. It is then mopped out and dried, and in many cases painted with spirit, partly to cause local reaction, and to promote adhesions. There were 15 cures, 2 patients could have been included in the cures, but died of other complaints. There have been 11 other deaths, 4 have ceased treatment. 29 cases are under treatment, some coming once in 3 to 4 weeks and some every 3 to 4 months, the patients coming when they feel a treatment is indicated, or when the foul odor demands it.

Babcock (4) introduces the bronchoscope every 7 to 14 days, empties the cavities by aspiration, and irrigates them with a mild antiseptic solution such as

Rx	Picric acid	gr.	ij
	Lucol's soln.	gtts.	vij
	Saline soln.	qsad.	℥j (Jackson)

The cavity may then be insufflated with bismuth subcarbonate or subiodide, or an oily instillation containing eucalypti, iodine, or other antiseptic used.

Although bronchial irrigation (lavage) was originally carried out through a bronchoscope, Stitt (110) and Wooding (122) and others, employ a soft rubber Coude' catheter. The latter employ a hypertonic saline solution, and have reported 35% symptomatic cures in a series of 100 cases. There was one death. The injection of iodized oil accomplishes the same purpose.

Singer and Graham (104) find a diagnostic pneumothorax in bilateral bronchiectasis not only of considerable aid in establishing a positive diagnosis as to which lobe is the more diseased, but if a patient is improved by this amount of compression (100 to 200 cc. of introduced air) pneumothorax treatments are continued. They say many startling cures have resulted from this treatment alone. The method they employed was to use 0.5% novocaine as a local anesthetic in the axillary area of the suspected side. The anesthetic is also injec-

ted into the pleura. The location of the puncture depends of course on the physical signs and the X-Ray findings. The nervous, high-strung patient is given twilight sleep. When the manometer on the pneumothorax apparatus shows that the needle is in the pleural space, between 100 to 200 cc. of air is introduced.

Alexander and Buckingham (1), (26) Singer and Graham (104), Marvin (79), Harrington (60), Whitaker (116) and Burrell (27) believe artificial pneumothorax is indicated in the early case when no adhesions are present. Riviere (93) and Royd (18) use artificial pneumothorax in the unilateral cases in which the lung and cavities seem likely to be collapsible.

Pinchin and Morlock (91) have used a means of cauterizing adhesions, by enucleating the adhesion at its parietal end, thus allowing the lung to collapse completely. They used it on two occasions with good results in that the general condition of both patients improved.

Eloesser (43) says complicated dilatations are always infected, and the complications are due to infection. He believes simple infected bronchiectasis may be given a trial with pneumothorax, combined if necessary with phrenic avulsion. Shenstone (99) has not had much experience with a pre-operative pneumothorax.



Brauer's statement ( 21 ) that he had never seen a patient with proved bronchiectasis cured by pneumothorax therapy has been substantiated by us ( 14 ). Very few with true bronchiectasis respond to pneumothorax even though collapse may be almost complete. The pneumothorax treatment may change the position of the lobe so that the dilatations become horizontal instead of vertical. Better drainage may result from this change of position. We have noticed it in two cases. In summarizing their experiences in cases of bronchiectasis treated by artificial pneumothorax, Whittemore and Balboni (117 ) stated that in successful cases the pneumothoraces must be kept up for a long time. In our experience (14 ) this is frequently impossible, unless the pneumothorax be replaced by an oleothorax. If improvement does not take place within three to six months, then it is not likely to occur. Pneumothorax treatment, however, does prepare the mediastinum for some future procedure, and it is perhaps indicated in the early forms of bronchiectasis in which the dilatations extend well toward the periphery. Our results do not permit us to recommend pneumothorax in the treatment of bronchiectasis. However, it would seem that certain acute inflammatory conditions of the lung which are likely to become chronic and lead to the development of bronchiectasis might, with profit, be treated by pneumothorax (14 ).

Oleothonax always follow pneumothorax. We (14) have used oleothonax in the treatment of bronchiectasis whenever we observed that the pneumothorax pocket was gradually becoming obliterated. The latter must frequently be abandoned after six months because of adhesions. (See<sup>91</sup>).

In oleothonax vegetable oils (olive oil) and liquid paraffin (U.S.P.X.) have been recommended. The oil is sterilized by heating. 5 cc. of gomenal are added to each 95 cc. of liquid paraffin and has been used in strengths up to 20% when antiseptic action rather than mechanical action, is desired. A few cubic centimeters of iodized oil or brominized oil may be added for purposes of more exact roentgenographic visualization. The iodized oil usually remains at the bottom while the liquid paraffin goes to the top. (And pleural fluid, if present, lies between the lipiodol and the paraffin.)

The action of oleothonax has been adequately grouped somewhat in the following manner by Gilbert: (a) Detoxicating, the pleural layers are made rigid, thick, impermeable; the absorption of toxins is decreased. (b) Mechanical, the action is blocking when the cavity is completely filled; when oil is under high pressure, the action is compressive. Oleothonax helps to stabilize the mediastinum. Gomenal may have a specific (?) (on tuberculosis, Clerc of Lysin) bacteriocidal action in certain cases, therefore, (c) Disinfecting.

The complications of pneumothorax, as thickening of the pleura and interlobular septa, formation of connective tissue which grows from interlobar septa and encapsulation of the process in the lung, may interfere greatly in bronchiectasis as adhesions, etc., may prevent the compression desired.

Oleoathorax may be used to help stabilize the mediastinum preparatory to a thoracoplasty or as adjunct to an incomplete thoracoplasty. It may also be recommended in the presence of small broncho-pleural fistula, and certainly as a substitute for a pneumothorax for economic reasons. Its use has been suggested in patients in whom pneumothorax treatments are followed by a reaction.

Contraindications for oleoathorax <sup>are</sup> (a) the presence of large bronchial fistula and (b) during the acute stage of serofibrinous pleurisy.

The technique of oleoathorax which Ballou (12) uses is as follows: Under local anesthesia the pleura is punctured as in a pneumothorax treatment. If a pneumothorax is already present, the air is gradually aspirated by means of a pneumothorax machine, and replaced with oil. It isn't always necessary to aspirate the pus that is present. A few cubic centimeters of oil are given at first to determine the patient's tolerance, and the first injection should not exceed 100 cc..

Sielig and Langfirst inject 10 cc. and put the patient to bed for 24-48 hours until the reaction, if any, is over, then 20 cc. of oil are injected, then 50 cc., then 100 cc. increasing the amounts until blockage or filling of the pleural cavity is complete. In all the proceedings, one must be guided by the reaction and symptoms of the patient. The patient usually lies in the lateral *décubitus* position with the affected side up. The same size needles are usually used for oleothorax as in pneumothorax treatment. In some cases two needles are introduced, the pressure being recorded from the uppermost one. After the injection of the oil, the patient should lie on the side opposite to the one treated for several hours, allowing the needle path to close, thus avoiding the possibility of a pleuroparietal fistula. Any signs of dyspnea or feeling of oppression during treatment or after it should be reported at once, because of the possibility of dangerous compression of the mediastinal contents following the expansion of the oil in cases in which the chest is almost full. Until one is well acquainted with conditions, it is wise not to fill the chest more than one-half or one-third. If compression symptoms should occur, they can be relieved at once with the withdrawal of a few cubic-centimeters of oil. Thoracoplasty, without delay offers the only chance of saving a patient if a cavity which connects with a bronchus ulcerates through into the pleural space, or because of excessive oil pressure the thin wall of the cavity ruptures.

Ballou (12) describes two cases in which bronchiectasis was present since early childhood. In the first, he cites a man 22 years old with bilateral bronchiectasis with rather classical symptomatology, and diagnosis confirmed by lipiodol injections. Pneumothoraces were given from March 17, 1930 to March 31, 1930, then oleothorax was done, 40cc. liquid paraffin were injected the first time. The second oleothorax was given April 7, 1930 when 60cc. of the same mixture was injected. Another 60cc. was injected on April 12, making a total of 160cc.. The oil separated into several pockets, and further injections were impossible. This oleothorax gave moderate collapse, but improved the patient's cough and expectoration very slightly. A right phrenicectomy was done May 17, 1930. The diaphragm rose but little, and following this the patient developed some dyspnea which partly disappeared gradually. This patient died at his home during October, 1931.

In the second case, a 28 year old female showed on physical examination including a lipiodol injection, a left lower lobe bronchiectasis. Postural drainage and pneumothorax treatments caused a striking improvement and her hemoptysis ceased. Pneumothorax was done at about 10 day intervals. A left phrenicectomy was performed by Dr. Graham and the diaphragm rose but little following this procedure. She continued receiving pneumothoraces in amounts varying up to 500cc., the final

pressures always being slightly negative. She also suffered from nasal sinusitis, so her nasal sinuses were treated. She had a turbinectomy performed. The sinuses all contained pus and their membranes were all thickened. About two months after her pneumothoraces were started, only 50cc. of air could be injected before the pressure became positive, so 20 cc. of liquid paraffin were injected into the pleural cavity and 50 cc. on the following day. Air was withdrawn before the paraffin was injected. Fluorescopic examination at this time showed that the cavity was two-thirds filled with oil. An additional 25 cc. were injected 3 days after the first injection, the cavity now containing 95 cc. liquid paraffin and was over three-fourths filled. Two days later the fluid shadow seemed to be larger; this increase in the amount of the fluid content was undoubtedly due to pleural reaction. The pulse and temperature curves remained unchanged. Oil was withdrawn at this time, cultured, and no growth obtained. 30 cc. of oil were injected 2 days later, and 20 cc. injected the third and seventh days after this. 15 cc. were again injected 18 days after this, making the total 180 cc., and filling the pocket completely. The patient has had no refills for 20 months. She has gained weight and her expectoration has been appreciably reduced since starting the oleothorax treatment. She has had only one attack of hemoptysis during the last two years.

With the increasing use of oleothorax in pulmonary collapse therapy, it is important to know the accidents which may accompany it. (63). Of 150 cases reported by Marie(77) and by Fontaine(48), 39 deaths resulted, some of which were directly attributable to the method. Küss(71) blames most of the errors on improper technique. Hayes finds reactions with paraffin oil frequent and slight, but has never had to substitute olive oil, or to stop on account of reactions. Febrile reactions are frequently followed by serous effusion, usually small in amount, and of no importance in itself. It may be dangerous, however, when it causes the gas pressure to rise too high. Increased respiratory and cardiac rates indicate need for lowering of gas pressure. On account of this possible rise in pressure, which may be sudden, the gas pressure at the beginning of the oleothorax should be left no higher than neutral. When serous effusion persists, increases, and must be aspirated repeatedly, it may become puriform, altho Fontaine says this is rare. Hemorrhagic pleurisy is also very uncommon. If the gas pressure is not under observation and rises high, the symptoms are very characteristic: "Sensation of malaise at first, followed by anguish with intense dyspnea and sensation of choking; it is really an accident of suffocation." (Fontaine) 63).

When oleothorax is used to try to control an established perforation, one must be very cautious. If the

perforation is valvular or temporarily closed, it may be re-opened by failing to control the overlying gas pressure. If the bronchopleural fistula is patent and large, one may incautiously force oil through the lung .

Oil embolism may occur. Oil may enter the circulation through the needle entering a vessel and, Hayes believes, oil under pressure may be forced into newly formed capillaries. Fontaine says that phlegmon of the chest wall has occurred from olive oil of poor quality (rancid, improperly prepared). She has heard of only one case of paraffinoma, and that in the mediastinum. Dumarest mentions paraffinoma of the chest wall.

A minor inconvenience is that, with oil in the pleural cavity, compression of the lung can't be watched as easily as with air. (63)



Lilienthal (73) believes that extrapleural compression by plugging of some kind, is best suited to disease of the apices. It is intended to diminish the size of the bronchiectatic cavities, reduce the discharge, and in some cases produce fibrosis and virtual cure.

Burrell (27) believes that pneumolysis or pleurolysis is good when adherent pleura prevents proper collapse of the cavities in localized bronchiectasis. Wax or fat is inserted between the pleura and chest wall. In intrapleural pneumolysis, the lung is freed by separating the parietal from the visceral pleura. (42).

Garre (51) has mobilized the lung after extensive rib resection for exposure, and sutured its edge to the chest wall at a level above the dome of the diaphragm, packing gauze into the space below. In this way he gets compression by upper displacement of the lung, and it results in marked improvement. Later he resects the diseased lobe.

The surgical treatment of bronchiectasis will depend upon the degree of danger or discomfort which the disease entails, and there is no essential difference in therapeutic procedure whether the lesion is caused by faulty embryological conditions, or is the result of postnatal disorders. Lilienthal (73) classifies the surgical procedures exclusive of therapeutic pneumothorax somewhat as follows:

(a) a major thoracotomy, intercostal only or supplemented by rib resection with loosening of adhesions to permit the lung to collapse, and to do away with intrapleural negative pressure. This is also useful as a means of full exploration of the pleural cavity. A major exploration may unexpectedly be followed by great improvement or even apparent cure in spite of adhesions which prevent full collapse of the lung. Peeling away part of the adhesions from the chest wall and packing with gauze seem to be responsible for this. It may have to do with relaxation of the tissues which had been held tense by their adhesions to the costal pleura. The method of carrying this out is, first, to make a long intercostal incision with resection of a few inches of one rib with its periosteum. After breaking down the adhesions if they are present, rubber dam, or vaselined gauze is packed upon the lung. If little abscesses are present they may be evacuated at this time and if a bronchus happens to be entered, so much the better. When the entire lung is adherent to the chest wall, the operation may be divided into stages, collapsing the lower lobe first. The packing should not be removed for from 5-10 days unless there appears to be retention behind it. There will usually be sufficient drainage beside it. With healing, adhesions will reform, but we may expect great improvement in the patient's condition. Harrington (60) believes surgical collapse beneficial.

(b) The drainage of bronchiectatic abscesses (by pneumotomy) is merely an expedient looking toward further surgery to extirpate the epithelial lining or to resect or destroy the abscess. Riviere (93) believes pneumotomy is suitable for single large suppurative cavities and for little else. The treatment of bronchiectasis by pneumotomy has been more or less discarded. (14). It is obvious that simple incision and drainage of a dilated bronchus can hardly be expected to accomplish much in the presence of other dilated bronchi which are not reached by the incision. In fact it is now well known that such is the case. A satisfactory result is seldom obtained because of associated bronchiectasis for which simple drainage doesn't suffice. (c) Bronchostomy, the deliberate formation of a mucocutaneous opening into a good sized bronchial branch, to areate dilated bronchi, to drain, and to destroy anerobic growth, has the advantages of giving much relief to patients in whom the more radical efforts at complete cure are not likely to be followed by success, or when the danger of these operations seems too great. These are the cases of multiple bronchiectatic areas in one or even both lungs in patients too old or not vigorous enough to permit what I (Lilienthal) term "maximum thoracic surgery." (d) Extrapleural thoracoplasty, with multiple rib resections preferably from behind (Sauerbruch), but perhaps supplemented with anterior resections as well. The operation should be in stages. Alexander and Buckingham (1,26) be-

lieve extrapleural thoracoplasty of value in the early case. Oakley (87) believes that phrenic avulsion should always be performed as a preliminary to thoracoplasty. Smith (108) believes that the operation which performs the most permanent relief and which is the safest to perform is external thoracoplasty, which lessens the size and shape of the thoracic cavity thereby lessening the negative pressure of the lungs and vertically closing up the bronchiectatic dilatations, squeezing out the pus. It can be performed with local anesthesia and in stages, according to the condition of the patient. Rivière (93) believes thoracoplasty should be reserved for unilateral cases in which the lung and the cavities seem likely to be collapsible. Marvin (79) recommends thoracoplasty and lobectomy when other less serious methods fail. Burrell (27) and Whitaker (116) believe that thoracoplasties give best results after artificial pneumothorax. Burrell says he has three cases in which thoracoplasty resulted in cure.

and

Ballou, Singer, Graham, (14) mention one patient whose bronchiectatic dilatations were compressed by a specially constructed belt, applied following partial thoracoplasty. This treatment was subsequent to change of climate, rest, 15 pneumothoraces, and an unsuccessful bronchoscopy. Her complaints and physical signs were the same as before, and as she was 47 years old and mother of several small children, no more radical treatment was thought to be indicated.

In the early part of 1931 Hedblom (65) stated the following, "In 1926 I reported 14 cases in which I had done a thoracoplasty in five stages without operative mortality. Three of the patients were entirely relieved and have remained symptom-free since. Seven of the patients have continued to raise sputum amounting to 10-20 % of what had been raised before the operation. Six of the seven have been working regularly. Four whose symptoms were greatly relieved, died from 10 months to 2 years after operation, one from actinomyces infection, one from drug poisoning, one from pulmonary hemorrhage, and one following secondary operation." Of the 32 patients subjected to thoracoplasty by Hedblom 21 are still alive. By graded extrapleural thoracoplasty Hedblom implies a collapse of the wall of the chest, i.e., paravertebral resection of the upper 11 ribs in several operative stages. In order to secure complete collapse of the base without collapsing the normal upper portion of the lung, he states that a complete resection of the whole length of the lower ribs is necessary and that resection of the third and fourth ribs must often be included in order to prevent their suspending effect on the lower part of the chest wall. (65). Hedblom believes that thoracoplasty produces a degree of collapse which can be made to approximate that following artificial pneumothorax, and it is his opinion that bronchiectasis

associated with multiple abscess formation clinically manifested by septic temperature, leucocytosis, etc., is not the type to be treated by thoracoplasty. Relatively few patients suffering from bronchiectasis have been subjected to thoracoplasty. lack of stabilization of the mediastinum, not dividing the operation into a sufficient number of stages, also operating on cases more than uncomplicated bronchiectasis (with parenchymatous abscess formation associated), all tend to give the poor results shown (14). However, as Hedblom said in 1924 (14) if results are unsatisfactory then lobectomy can be performed. To Singer and Graham (105) their experience with thoracoplasty in the treatment of chronic pyogenic bronchiectasis has not been so satisfactory as the reported results of others. Weinberg (115) is thoroughly convinced that thoracoplasty is of but little value.

Phrenic avulsion, the extraction of a piece of the phrenic nerve through an incision at the base of the neck to paralyze the corresponding side of the diaphragm in order to secure rest of the lung has been used in the treatment of bronchiectasis. (42)

Bailey (5) explains the action of paralysis in the diaphragm, threefold (a) rest to base of lung by decreasing the respiratory excursion of the involved lobe (b) decreases

the volume and lowers the pressure of the thorax on the affected side (c) cough is modified and sputum is more effectively raised, because a thin membranous fibrous sheet devoid of muscle elements (after paralysis of diaphragm with muscle atrophy) "flips" up into the thorax with more expulsive force than a normal side, when the patient coughs. Riviere (93) believes phrenic exeresis may partly eliminate and assist drainage in bronchiectatic dilatations.

The clinical anatomical effects of phrenicotomy or the surgical division of the phrenic nerve, are similar to those of artificial pneumothorax and thoracoplasty though less marked, because the relaxation afforded is less marked. (29). Due to a modification of the blood and lymph circulation which takes place in the lung, the motion and volume of which is diminished, there is a reduction in the spread of toxins from the lesion in the lung. Therefore, within a short time the temperature, pulse, and general condition of the patient are often much improved. When the phrenic nerve is crushed, its function is restored in from 6 to 12 months. When it is avulsed, the paralysis is permanent. As it is very doubtful that bronchiectatic cavities ever become cured at all, and as the chief benefit is the mechanical one of improved drainage, there should be a permanent paralysis. Burrell (27) and Whitaker (116) believe phrenic avulsion is indicated with benefit.

Shenstone (99) operated 15 cases of bronchiectasis, removing one or more lobes. In 14 of the cases the diaphragm was paralyzed by crushing the phrenic nerve a few days before the major operation was performed; in one case it was partially resected. Eloesser (43) believes that simple infected bronchiectasis may be given a trial with pneumothorax combined if necessary with phrenic avulsion. Singer and Graham (105) mention that phrenicectomy may be followed by interference with the expulsion of pus by coughing, and occasionally results in severe suppurative pneumonia. Marvin (79) recommends artificial pneumothorax and phrenic exeresis although he reports a case with unilateral involvement in which a phrenic exeresis was done which later developed the disease in the opposite lung (Internal drainage??-Faulkner (45) ).

Alexander and Buckingham (1,23) and Harrington (60) believe that phrenicectomy is indicated in the early case. Oakley (87) found that in a series of 17 cases of bronchiectasis, phrenic avulsion gave the following results:

complete relief of symptoms	4 cases	23.5%
lasting improvement	7 cases	41.0%
temporary improvement with relapse	6 cases	35.5%

He concluded that in experienced hands, phrenic avulsion is a safe operation and the complications are more to be feared in theory than in practice; that only in strictly basal and unilateral cases of bronchiectasis can phrenic avulsion be



reasonably expected completely to relieve the symptoms; that improvement is to be expected in unilateral bronchiectasis in which the lesions are confined to the bases and not advised on the better side; that in unilateral bronchiectasis in which the lesion extends into the upper or mid-zones, temporary improvement is the rule, but relapse must be expected unless thoracoplasty is performed; that in bilateral basal bronchiectasis with lesions in the upper or mid-zones, little benefit is to be hoped for from unilateral diaphragmatic paralysis; and that as a preliminary to thoracoplasty, phrenic avulsion should always be performed, but should not be allowed to shelve the larger operation in an event of a brilliant but temporary cure.

Dyspnea constitutes a definite contraindication to phrenicectomy in certain cases. If it is due to adhesions between the pericardium and diaphragm, then phrenicectomy may be helpful. However, phrenicectomy usually increases the amount of dyspnea present (66). Cardiospasm following left-sided and right-sided phrenicectomy has been reported in the literature (14).

The physical signs are usually uninfluenced by the phrenicectomy, even in cases in which benefits are striking. The size and shape of the dilatations remain unaltered. It would seem that beneficial results of phrenicectomy in cases

of bronchiectasis are nearly always observed if the diaphragm rises. In a large percentage of cases in which the results were poor the diaphragm failed to become elevated following its paralysis. It was hoped that since bronchiectasis is so frequently basal phrenicectomy would be a valuable means of treating hemoptysis. It is as yet impossible to draw any definite conclusions in this connection since sufficient cases are not available. We have observed some striking results. Others have reported similar striking results. (14)

Apparently, from 82 cases considered in the literature (14) 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 made worse. Even when improvement occurs, it is usually not lasting. In some cases, the bronchi become more horizontal and this results in more adequate drainage. There are few occasions in which cough is completely abolished by phrenicectomy, and rarely, it aggravates the cough. Of greater significance is the fact that the abolition of cough may cause some harm, in that expectoration is more difficult and sometimes almost impossible. Phrenicectomy may reduce the amount of expectoration to a striking extent, even causing its disappearance. This effect is unfortunately not always lasting.

We have noticed no striking effect upon fetor in cases of bronchiectasis treated only by phrenicectomy. ( ) In Wilson's experience, ( ), the effect of combined artificial pneumothorax and phrenic avulsion on the fetor was most marked. The fetor was made not offensive or at least less offensive in most of his cases.

The results of phrenicectomy as a prophylaxis against the development of bronchiectasis, so far, are far from satisfactory.

Bruns and Sauerbruch (25) produced carnification of the lung by ligating the branches of the pulmonary artery. It was hoped that this procedure might be of value in the treatment of bronchiectasis, by influencing hemoptysis which may be so striking a manifestation of the disease. In 1914, Willy Meyer reported that a branch of the pulmonary artery had been ligated for bronchiectasis on 11 occasions (Sauerbruch 7; Morrison Davis 1; Willy Meyer 3). At this time Meyer stated that all patients were improved, but none entirely free of their expectoration (82). In 1917, he presented a patient whose branch of the pulmonary artery going to the right lower lobe had been ligated 4 years previously (1913). Meyer then stated that his 22 year old patient had been annoyed previously by frequent expectoration of a very large amount of very foul muco-pus, but following the ligation of the branch of

the pulmonary artery to the diseased lobe, expectoration was reduced from 350cc. to 15-30cc. in 24 hours.

Bronchiectasis has been treated by cautory pneumectomy (Graham) (52), (55). Sauerbruch's operation is a lobectomy performed by the cautory. Our (14) operation, on the contrary, is based on the idea of removing only the diseased portion of the lobe, although occasionally subtotal lobectomies have been performed. Harrington (60) believes a partial pneumectomy to be of value. Bronchiectasis associated with multiple lung abscesses and chronic lung abscesses with secondary bronchiectasis, are the types most suited to cautory pneumectomy. Burrell (27) tried cauterization in two cases, both died. Eloesser (43) believes that when there is ulceration of the bronchial walls and true abscess formation, (complicated bronchiectasis), in patients unable to withstand more severe procedures, they may be opened with the cautory. Whitaker (116) believes cautory pneumectomy to be of value. Those forms subsequent to the bronchopneumonias of the exanthemata, pertussis, and influenza, and to similar lesions due to foreign bodies, respond well. The presence of an associated bronchopleural fistula or empyema doesn't retract from the expected result. Singer and Graham (105) prefer to use cautory pneumectomy in those cases in which the predominant lesion is a chronic abscess of the lung, either single or

multiple. Cautery pneumectomy doesn't seem to be suitable for those cases of bronchiectasis which are perhaps of congenital origin and which are associated with long and wide dilatations in the lower lobe. (Sacular type). It should be employed with caution in the presence of extensive bilateral lesions, because if the opposite lung is badly diseased the patient may observe but little or no improvement regardless of the result obtained on the treated side. To put it more concisely, one can state that cautery pneumectomy is recommended to those suffering from unilateral types of bronchiectasis who have not responded well to the simpler forms of therapy, for whom thoracoplasty is either not indicated for various reasons, or has failed to relieve the symptoms, and upon whom the performance of a lobectomy, although desirable, is unwise or technically impossible. (14). The operation can be made to combine the three cardinal principles of the surgical treatment of chronic pulmonary suppuration, namely, (a) drainage, (b) compression, (c) extirpation. It can be performed in multiple stages with relatively little disturbance to the patient which makes it suitable even in patients whose vitality is low. Lilienthal (73) uses Graham's technique, which is as follows:

At the first stage, the field is exposed by turning up a flap of skin and muscle and the removal of two

or three ribs for distances of about three or four inches. The ribs are removed by subperiosteal resection, and the periosteum is then peeled off the pleura with the intercostal bundles, including the intercostal muscles, vessels, and nerves. This procedure, in itself, permits an appreciable amount of compression of the affected lung tissue, although, of course, not to the same extent as in a thoracoplasty. The exposed ends of the ribs are packed with bone wax to minimize the danger of osteomyelitis. The diseased portion of the lung is now in view, covered by pleura to which it is often densely adherent. It is essential, before proceeding further, that the lung should be firmly adherent to the pleura. Otherwise, after the pleura has been penetrated, the lung will retract away, and an empyema will result. To determine definitely whether or not the lung is adherent, the pleura should be opened. If the lung is found not to be firmly adherent, adhesions can be created by any of the standard methods, such as suture and gauze packing against the pleura. If, while making the investigation, the lung has become retracted away from the pleura by an inrush of air into the pleura cavity, it will be found best then to inflate the lung by positive pressure, to close the pleura, to pack gauze against it and to postpone any further operative procedure until after the lung has become adherent. After the exposure

has been made, the first stage of the operation can then be terminated and, in patients who are bad risks it is well not to proceed further at this stage. No sutures are placed in the flap.

After the lapse of about ten days the first cauterization can be done, or, if the patient is in good condition and if adhesions are known to be present between the lung and parietal pleura the first cauterization can be performed at the time of making the exposure. With a large soldering iron heated to a red heat, an excavation is then made into the lung tissue. If an old drainage tract exists it is well to begin the cauterization by plunging the hot iron into the sinus and to work out from that eccentrically. Other abscesses are sometimes found in this way lying close to but not communicating with the main drainage tract. In the cases in which the pathological condition is bronchiectasis, the first objective is to provide multiple drainage openings by exposing a large cross section of the bronchial tree. To accomplish this, the effort is made to begin by burning over a fairly large surface instead of by burning too deeply into the lung. After the slough has separated there is sometimes as many as 10 or 15 bronchial fistulae from each of which pus exudes. As a rule, the better the drainage is established, the more rapid will be

the convalescence. Repeated cauterization should not be done too soon. Our experience has shown that it is better to wait about three weeks before repeating the cauterization. In some cases, less cauterization was necessary than had been originally supposed, if several weeks of free drainage through multiple bronchial fistulae has been permitted. There is undoubtedly some tendency in even the long standing cases for the diseased tissue to heal if adequate drainage of the pus is provided. The establishment of many bronchial fistulae by a cross section of a relatively large part of the affected lobe provides better drainage than can be accomplished in any other way. The effect of the heat from the cautery is transferred a variable distance away from the place with which it is actually in contact and this effect doubtless leads to the destruction of more secreting surface. In some of our cases one cauterization has been sufficient and in others three or more have been undertaken. It is better to do too little at a time rather than too much. If hemorrhage from a large vessel occurs it may be controlled by packing, and the operation is terminated then. It is well, in such cases, not to remove the packing until after 7 to 10 days. If the pack has become loosened spontaneously, it may be removed before that time, followed by the application of a fresh packing.



Usually there is no shock and the patients look as though no operation has been performed on them. For the first 24 or 48 hours there may be either a marked diminution or a complete absence of cough or sputum. Generally on about the third day, the patient develops a little fever and complains of malaise, loss of appetite, and even sometimes of nausea and vomiting. These symptoms are apparently due to intoxication from the burnt tissue, and they form another reason for not performing a too extensive cauterization at one stage. The symptoms of intoxication are likely to persist until the slough has separated, usually about the tenth to twelfth day. Coincidentally with the appearance of these symptoms, the cough and sputum may be increased, and may actually become greater than before the operation. Later as the slough separates and as the open bronchioles begin to discharge <sup>pus</sup> to the outside, the cough and sputum diminish, the fever disappears, the appetite returns and the patient feels well. In two cases during actual cauterization death has occurred on the operating table preceded by signs of cortical irritation. It seemed probable that these deaths were due to cerebral embolism, possibly of air. Hence, the possibility of cerebral embolism exists as a greater danger than hemorrhage. (15).

The results of cauterization in 21 cases of chronic

lung suppuration were published by Graham (56) in 1925. Six patients (30%) were free from symptoms and completely healed. Six patients (30%) were free from symptoms, but had bronchial fistulae. Three patients (15%) showed marked improvement. There were four deaths (20%). In two cases the improvement was still in progress and one patient was lost track of.

The following table (15) impresses one with the low operative mortality in a large series of cases and with the excellent late results.

Results of operations of cauter, pneumectomy performed prior to 1930, not including carcinoma of the lung.

Number of cases	54	
Definitely improved	36	(66.6%)
Moderately improved	2	( 3.6%)
Slightly improved	3	( 5.6%)
Not improved	7	(12.6%)
Dead (operative mortality)	6	(11.0%)

Number of cases	54	Late results
Number of patients still alive	36	(66.6%) All pts. at work
Definitely improved	34	(63.0%)
Moderately improved	1	( 1.6%)
Slightly improved	0	
Not improved	1	( 1.6%)
Operative deaths	6	(11.0%)
Late deaths not due to operation	12	(22.0%)
Bronchial fistulae still present	17	(47.0%) of living pts.

In five of the ~~17~~ seventeen cases, the fistulae have closed since this table was published. Open fistulae remain in only 12 cases which makes (33.0%) of the living patients, and some of the 12

have declined any operative attempts at closure, because the inconvenience of the fistulas to them is slight.

In the above table the expression "definitely improved" signifies that the patients so designated have been able to return to their normal activities, and they are free from all symptoms except that in those noted a bronchial fistula remains. The expression "definitely improved" is probably more appropriate than "cured."

Bronchial fistulas, the result of cautery pneumectomy are never allowed to close before one is quite certain that the diseased bronchii and lung tissue have been adequately treated. They are, therefore, seldom allowed to close before several months have elapsed. There doesn't seem to be any definite indication that the existence of a bronchial fistula always constitutes a menace, however, it is desirable that they should eventually become obliterated. In most cases, this takes place by circular contraction of scar tissue (Bettman) and conversely, spontaneous closure is prevented usually because of the inability of the scar tissue around the bronchus to contract because of firm fixation of the lung to the chest wall.

Bettman (16) has found the method of cautery pneumectomy satisfactory in five cases. Four of the cases are considered to be clinically well. There was one death.

Coquelet (33) removes wedges of lung tissue in

his cautory pneumectomies. He has performed this so-called "cuneo-pneumetomie" on six patients. Three were completely cured without fistulas, one patient was cured of his suppuration but still has an open cavity. The fifth patient is still receiving treatment, but is considerably improved. One patient died of massive bronchopneumonia in the opposite lung.

For several years, lobectomy in the treatment of bronchiectasis was abandoned, probably because of its high operative mortality. However, with the recent reports 212 cases are available in which lobectomy has been performed. Although improvements in methods of operating have been introduced in recent years, the operation remains, even in the best hands one of the most serious in the surgical repertory. Of the 212 collected cases (15) no less than 72 patients (34%) have died apparently because of the operation and apparently in only 99 patients (47%) was a thoroughly satisfactory result obtained. Even if we take the more recent and more favorable figures, we still find that a patient with bronchiectasis who submits to a lobectomy runs about a 15-20% risk of dying because of the operation, and that if he recovers from the operation he has only about a 65% chance of having a thoroughly satisfactory result with solid healing of the wound. However, it is probable that most of those who have obtained

satisfactory results have been saved from death due to the natural consequences of the disease; and most of those who have died as the result of the operation would have died if left untreated. Up to the present time lobectomy has very little to offer to patients with excessive bilateral bronchiectasis. One case of bilateral cautery pneumectomy has been reported, and we are told that Eloesser has performed a successful bilateral lobectomy for bronchiectasis. (15).

Lilienthal (73) states that he has submitted 42 patients to lobectomies. This group of resections includes some subtotal pneumectomies, and cases in which resection of a greater part of a lobe was performed. The lesion was in every instance non-tuberculous. 27,--(64.3%) of these patients are dead as a result of the operation. One patient, not among the 27, died more than nine years after an extensive pneumectomy when the left upper and part of the lower lobe had been removed. This patient was well save for a bronchial fistula, was active, and apparently in good health. He died rather suddenly from pulmonary tuberculosis. The findings in this case were confirmed by necropsy. The above is the only subsequent death which occurred among the 15 patients who recovered. Four other patients have bronchial fistulas, one permanent, the other three expected to heal. The last four consecutive cases are entirely well or convalescent with bronchial fistulas which are expected to close.

Lilienthal is convinced that all these 42 patients would have been dead by this time without operation, and that none of them would have been well without lobectomy. He is of the opinion that better results can be expected when the operation is divided into two stages, particularly in those cases in which adhesions of the chest wall to the lung are not present at the time of exploration. When all things are considered, this will not deter most patients from taking the risk if they have suffered for a year or more, for by this time life has often become intolerable. And the result is one which in the event of success offers a cure with little or no apparent deformity and with excellent function, both visceral and general. Extirpation of the suppurating bronchiectatic mass also has the advantage of removing the danger of malignant degeneration of the lung. (73). His present procedure at the first stage is:

"A long thoracotomy through an interspace usually the seventh, when a lower lobe is to be resected, or, in contemplated upper lobe resection, a continuation upward posteriorly with the division of three or more ribs, so that ample space may be had by retraction. Adhesions are secured by rough friction with gauze dipped in tincture of iodine. At this first stage there may be a long resection of one rib or none at all according to the possibility of spreading with retraction or because of the need of speed. A dependent opening is made with valvular tube

drainage and the large wound is completely closed by sutures. A week or more later, the second stage of the lobectomy is performed. The stump is isolated, crushed, and ligated in sections with heavy chromicized catgut, the ends of which are left protruding from the wound posteriorly. A large stump is left and every vessel whose mouth can be seen is separately ligated. This is done because in many of these cases the pedicle is indurated and the vessels contained therein may not have been crushed sufficiently, so that early atrophy may permit reestablishment of the lumen. The long end of the stump ligatures are drawn out of the wound posteriorly and are fastened in place with a safety pin after tying them together. The wound is then closed and covered with an occlusive dressing, but the original low drainage tube is left in place outside the dressings, and good valvular suction drainage is provided. Lilienthal has recently preceded the operation of lower lobe removal by avulsion of the phrenic nerve. He apparently considers this procedure advantageous.

Brunn and Faulkner (23) had five cases of lobectomy for bronchiectasis with one death due to hemorrhage, which was probably preventable, and they removed the lower and middle lobes of a very interesting case which proved to be a carcinoma of the lung. In lobectomies, they followed the technique of Lilienthal, modified from time to time as experience seemed to direct.

Carre (51) has mobilized the lung after extensive rib resection for exposure, and sutured its edge to the chest wall at a level above the dome of the diaphragm, packing gauze into the space below. In this way he gets compression by upward displacement of the lung and it results in marked improvement. Later he resects the diseased lobe.

Guibal (57), who is credited by some as having performed the first successful two-stage lobectomy, has reported six lobectomies with five deaths.

Zaaijer(123) in 1927 reported a case in which preliminary phrenicectomy was followed by rib resection which included the periosteum and intercostal muscles. The diseased lobe was then isolated intrathoracically and was tamponed. The tamponed isolated lobe was finally incised and resected. This procedure was apparently quite successful.

Coryllos (34) states that he has performed seven lobectomies for bronchiectasis with two deaths. One of the successful cases listed as a lobectomy, was actually a cautery pneumectomy. On six occasions he performed multiple stage lobectomy similar to that described by Zaaijer. The successive stages include pneumothorax, phrenicectomy, thoracoplasty, and then lobectomy. In six of his patients bronchial fistulas followed the operation. These closed in from four to six months following the operation. In one patient no bronchial fistula resulted.



Brunn in 1929, reported six lobectomies with four cures, one improvement, and one death. (22). He recently states he has done eight lobectomies with one death. (24).

Nissen (85) reported the successful removal of the entire left lung for bronchiectasis.

Robinson (94) in 1917, reported five resections of the lower lobe of the lung for bronchiectasis with one death. In a subsequent report, however, this number was increased to seven lobectomies with three deaths. (94).

Weinberg (115) has done three lobectomies with one death.

Hansen (59) has reported three cures and one death.

Hitzrot reported a successful lobectomy. (68).

de Quervaine has also reported a successful lobectomy. (39).

Burrell (27) believes that lobectomy is indicated in only the most severe cases, and is rarely if ever justified in bronchiectasis. Of the surgical measures previously discussed, Burrell has had the experience of having some of his patients go through with as many as five of them, and then have to be content with postural drainage.

Rivière, (93) believes that lobectomy and cautery lobectomy can only be considered for well localized areas of disease. A combination of two or more methods may best meet individual needs under some conditions.

Alexander and Buckingham (1,26) use a lobectomy, of two stages, in the late stages of the disease while the patient is still in good condition, with operative mortality of 20 - 30 % in their hands. Their method is to use the simplest appropriate measure first, and as soon as it is found to be inadequate, the next more radical method is used.

Eloesser ( 43) believes that a two or more stage lobectomy is indicated for the cases of complicated unilateral bronchiectasis, if the patients are rather robust. The chest is left open, and the hilus fixed with clamps, sutures or packing. When toxicity, sepsis, or cyanosis and marked dyspnea is present, operation on the chest wall is contra-indicated. They permit only pneumothorax or phrenic nerve avulsion.

Flick (47 ) states that he has performed three lobectomies with two deaths and one complete cure. The type of operation differed in each case.

E. A. Graham (15 ), 1922, reported three lobectomies for bronchiectasis with one cure and two operative deaths. The operations were performed in two or more stages. In the first case, which was the successful one, it was noted that the comparatively slight postoperative difficulty was due probably to the fact that the uninvolved upper lobe was firmly adherent to the chest wall. In the published reports of these cases the comment was made, "Any procedure which will permit the easy and safe creation of firm adhesions between the un-

affected portion of the lung and the chest wall will serve greatly to reduce the mortality of the operation, for the double benefit of a minimum of pleural cavity to be infected and a minimal amount of respiratory disturbance during and immediately after the operation will result."

According to John Alexander (1), the gentle wiping of the entire interpleural surface at the first stage causes a traumatic pleuritis with infiltration and marked thickening of the subpleural layer which presumably, serves as a partial protective barrier against the inevitable interpleural infection that follows the second stage of the operation performed 10 - 12 days later. It is also said to serve as a protection against the development of mediastinitis. In addition, the traumatic pleuritis causes the undiseased upper lobe to become firmly adherent to the thoracic parietes, during the interval between the first and second stages. This "prevents what would otherwise be a grave total hemithoracic empyema." He states that each stage of the operation can usually be performed in less than thirty minutes. This he considers to be a great advantage to patients who have long been ill from a toxic disease. He feels that this period is considerably shorter than that employed in a one stage lobectomy. Alexander has had 12 cases of two stage lobectomy for bronchiectasis. Five (41.66%) are completely cured (no sputum and wound closed); two (16.66%) greatly improved; two improved (16.66%); one (8.33%) operated

on too recently to judge result; none unchanged or worse except two (16.66%) dead. By excluding the too recent case, nine (81.81%) of the eleven are either cured or improved and in eight of them the wound is closed, the remaining one having a pin-sized opening that is sometimes open, sometimes closed.

In the two fatal cases of Graham, an effort was made at a preliminary stage to create such adhesions. One of the patients died apparently because the attempt was unsuccessful, and the other on the fifth postoperative day from an extensive bilateral bronchopneumonia, although firm adhesions had been produced successfully between the upper and middle lobes and the chest wall as the result of the operation. It is probable that the fatal pneumonia was induced by the spilling over of secretions from the infected lobe into the healthy portions of the lung at the time of lobectomy, a danger which has been particularly emphasized by Archibald ( 3 ).

Faulkner (45 ) explains postoperative mortality as due to internal drainage, which is the spilling of intrabronchial secretions from the diseased bronchus into the neighboring bronchi of either lung. This results in a dissemination of the infection and an obstruction of the air flow. It explains postoperative pulmonary atelectasis (massive collapse) and deaths ascribed to postoperative cardiac failure, bronchopneumonia, cerebral or pulmonary emboli, operative shock, or scopolamine toxicity. These postoperative complications may

be prevented if there is careful choice of anesthetic, selection of proper posture, and strict attention paid to hemostasis and to the removal of excess intra-bronchial secretions. Expectorants should be used instead of atropine and all measures tending to aid in the evacuation of pus should be fostered. There should be a bronchoscopic aspiration before and after the operation. The Trendelenberg position should be employed not only in the operating room but also after the patient's return to the ward. Nitrous oxide and oxygen should be the anesthetic of choice, as the narcosis is not so persistent after the operation, and the patient is better able to expectorate and cough to remove the collected intrabronchial secretions, than after scopolamine anesthesia, for example.

The technic that Graham used in the successful case is noted in the following case report (in part) :

Male, Age 17, Bronchiectasis left lower lobe. Complaints of chronic cough with excessive amount of foul expectoration. Had postural drainage treatment and pneumothorax treatment previously. The physical exam showed findings characteristic of bronchiectasis. The first stage of the operation was performed November 6, 1920. About five inches of the seventh, eighth, and ninth ribs on the left side were resected from the angles of the ribs to the mammary line. The corresponding intercostal bundles were excised. The pleura was apparently adherent and was not opened. The first stage terminated after closing the skin with silkworm and silk sutures, without

drainage. There was no marked reaction to the first stage operation, but an elevation of temperature one degree, and a faint trace of albumen with a few hyaline and granular casts. Healing occurred by primary intention. On November 22, the old flap was turned up; the pleura was opened, with but little change in the respirations at first. The upper lobe was adherent to the parietal pleura. There was also extensive adhesions between the diaphragm and lung. The lower lobe was dark, firm, and nodular. Adhesions between the lung, diaphragm, and chest wall were broken up with the finger. Gauze soaked in petrolatum was packed about the lower lobe. The second stage was terminated. Reaction was more severe after the second stage than the first. The temperature on the following day was 101 degrees F.; pulse 110; respiration 22. There was considerable discharge of bloody serum. On the sixth day after operation, the packing from the chest was removed, under nitrous oxide anesthesia, and three Carrel tubes were inserted for irrigation with Dakin's solution. The temperature continued to be elevated, reaching a height of 104 degrees F., until the ninth day postoperative (December 1), when it fell to practically normal and remained so until the third stage of the operation, which was carried out under nitrous oxide anesthesia on December 31. The old incision was reopened and the lung was found to have retracted upwards somewhat. In order to provide more space, about four inches of the fifth and sixth ribs were removed. The lower

lobe was densely adherent all around. Many adhesions had to be cut. The greatest difficulty was in separating the adhesions between the lung and diaphragm. The separation between the upper and middle lobes was easy. Curved clamps were placed on the hilus, and the lobe was amputated. The clamps were left in position. The wound was packed with petrolatum gauze and covered with several pads to exclude air. The operation was well tolerated and lasted forty-five minutes. On January 3, the clamps were removed from the hilus without bleeding and with no evidence of bronchial fistula. There had been very little reaction to this stage of the operation. The maximum temperature was 102 degrees F. with an average of about 100 degrees F.; average pulse rate 130; respirations 25. There was no cough. Dakin irrigations were continued regularly from the time of removal of the clamps. On January 8 the patient tasted Dakin's solution for the first time and began to cough during the irrigation. January 10 a bronchial fistula was observed. Instead of ordinary Dakin's irrigation, one irrigation a day was substituted, with the patient in a sitting posture, care being taken to avoid entrance of fluid into the fistula. Recovery was practically uneventful except for an attack of acute tonsillitis. He was discharged from the hospital February 19, with a bronchial fistula about the size of a lead pencil. This healed completely and spontaneously about two months later, and has remained healed ever

since. The patient has been well and at work for over ten years. He indulges in athletics and is an amateur boxer of considerable ability.

Whittemore (118) has reported 10 lobectomies performed after exteriorization of the diseased portion of the lung. 7 patients recovered and 3 died, a mortality of 30%. 2 died of pneumonia in the good lung, the first, 10 days after operation, and the second, two weeks after the operation. 6 of the 7 patients who recovered are stated to be in good condition. 4 of these have no sputum, and 2 don't expectorate more than a dram of sputum every 24 hours. The seventh patient is well as far as the side operated on is concerned, but has developed disease in the other lung. The wounds of all of these patients are healed, and their bronchial fistulas apparently closed without the necessity of any further surgery. Whittemore states (119) that he has had two cases in which he could not deliver the lobe satisfactorily. In these cases he packed gauze around it with the result that the lobe gradually sloughed away. One patient is perfectly well as the result of this procedure and the other left the hospital much improved and with a sinus, the latter patient has been lost sight of, but he was known to be doing well three or four months after leaving the hospital. The technique which Whittemore employs has been described by him in the following manner: the pleural cavity is opened



after the section of a considerable portion of the seventh rib. The opening is spread widely. If lobectomy is then decided upon, sections of a sufficient number of ribs are removed so that the lobe can be delivered from the pleural cavity after adhesions and the pulmonary ligament are divided. The lobe is then sutured to the muscles of the chest wall, the sutures being placed as near the root as possible. In some instances Whittemore has placed an elastic tourniquet about the root of the lobe. The lobe is then surrounded by gauze, a catheter directed to the root of the lung and the wound closed. The lobe is allowed to slough away gradually, and this is usually accomplished in 3 to 4 weeks. The pleural cavity becomes obliterated by the inflation of the upper lobe and the rise of the diaphragm, and in Whittemore's experience during this period the fistulas become closed. Drainage is to be maintained until the cavity is obliterated. In certain instances Whittemore recommends the performance of a preliminary thoracoplasty.

Dolly (41) has performed a successful two stage lobectomy according to the method described by Whittemore. The patient is said to be in excellent condition.

E. A. Graham (53) has also performed three subtotal lobectomies according to a method described by Whittemore in 1927. One of the patients died. In one of the other cases the persistence of bronchial fistulas with a copious discharge

of pus made the result unsatisfactory. It will probably be necessary to remove the remaining portion of the lobe. In the third case an entirely successful result was obtained from a two stage operation performed seven years ago. At this operation a lower lobe was exteriorized and ten days later, the portion outside of the skin was cut off with the cautery.

Shenstone (99) operated 15 cases of bronchiectasis removing one or more lobes, after the cases had been for a considerable period under the care of expert physicians and all the simpler forms of treatment had been tried without sufficient benefit to warrant their continuance, and no case was considered suitable for transfer to the surgical wards until lipiodol injections had, as far as possible, excluded bilateral or multilocular disease. The first case had a lobectomy performed six weeks after a wide lower thoracoplasty. Considerable hemorrhage and shock was encountered and only a rapid and inadequate closure of both the pedicle and wound was possible, and the patient died five days later from septic pleurisy, and pneumonia. A long incision in the general direction of the ribs, usually sixth interspace, from the angle of the <sup>s</sup>capula to the costal cartilages in front is made, under spinal anesthesia. When the lung has retracted, the intercostals with the underlying pleura may be divided safely from the costal cartilages to the angle of the ribs, and the <sup>v</sup>would spread widely with self-retaining retractors giving an enormous exposure. Adhesions,

if encountered are separated by a combination of sharp and blunt dissection, care being taken to avoid wounding the lung. When the diseased lobe has been freed completely, a snare of heavy cord is passed around it as near as possible to the mediastinum, and the loop drawn tight in the instrument designed for the purpose. (Similar to tonsil snare). Without devitalization of the tissue it controls the blood supply, obstructs the bronchus, provides a solid support during the suture of the pedicle, and can be used in limiting mediastinal movement during the operation. A second snare is used 1.5 inches distal to the first to prevent the escape of the infective material during the section of the lung. After sectioning the lung, obvious vessels are caught with forceps and ligated, and a running suture of chromic catgut is introduced across the pedicle, but not including its pleural margin. The snare is then released and the suture is tied. A further running catgut stitch closes over the pleural margin, endeavoring to invert the edges in the process, and the stem is sutured to the under surface of the upper lobe. A small incision is then made in the ninth inter space in front of the mid-axillary line through which the end of a long tube of 32 F caliber is drawn. The fenestrated end of this tube is placed about one inch away from the pedicle of the resected lung, and maintained in place by a catgut suture inserted into the summit of the diaphragm. The wound is closed in layers. Interrupted chromic

catgut sutures inclosing the adjacent ribs bring the edges of the long rent in the intercostals easily and accurately together. As soon as the pleura is closed, the distal end of the drainage tube is placed under the surface of a mildly antiseptic solution contained in a bottle, maintained at least two feet below the level of the chest and the patient is asked to cough, which expresses the air from the pleural cavity, permits the rapid expansion of the lung, and prevents mediastinal flapping. At the end of 24 hours they attach a continuous siphon drainage to this tube using a column of water 18 inches high. Its use is continued until the tube is withdrawn or a fistula develops.

Of 14 cases operated on in one stage, 9 cases were for excision of the lower lobe only; 3 for the excision of the right middle and lower lobe at the same time, and 2 cases of excision of the left lower lobe with the removal of a considerable portion of the left upper lobe, too. Of the 14 cases 3 have died, 2 with diffuse septic pneumonia a few days post-operative; the third of secondary hemorrhage 8 months following the primary resection and 3 weeks after a plastic operation performed for the closure of a persistent fistula. Shenstone(100) states that he has performed 16 lobectomies with 3 deaths. He has employed spinal anesthesia in his last 8 cases, and has found it much more satisfactory than any other that he has employed. He uses between 250 to 300 mgms. of novocaine dissolved

in 10 to 12 cc. of spinal fluid, and in no case has he had to use any general anesthesia. He gives his patients a sedative of nembutal gr.  $\overline{iiij}$ , morphine gr.  $1/4$ , and atropine gr.  $1/150$ .

Archibald (3) states that he has 9 cases of total lobectomy for bronchiectasis. His death rate, dependent upon the operation of lobectomy is 2 out of 9, 2 other deaths being due to later operations connected with carcinoma of the stem bronchus. Technique; in 7 of the 9, the technique has been approximately that of Shenstone of Toronto. That is, a one stage operation, through a long intercostal incision, or with resection of one rib, with tourniquet for the stump, to control hemorrhage, and another tourniquet on the lung, to prevent the outflow of pus, ligation separately of bronchi and vessels and covering over the stump with the lung cuff, followed by a complete closure, with closed drainage and continuous aspiration. However, in the last 4 cases Archibald has added to this procedure what he expects will prove a very valuable measure of safety; namely, the preliminary introduction of a small inflatable balloon into the stem bronchus of the diseased lung. The instrument consists simply of a gum elastic Coude' catheter, to the end of which has been attached a rubber balloon. His analysis, several years ago of the cause of death following operation for lung abscess and bronchiectasis, showed that the most frequent cause of death was an acute infection of the good lung, from the as-

piration of pus, during anesthesia, from the diseased lung.

Hedblom (66) states that he has performed 4 lobectomies, all of them secondary to thoracoplasties and originally performed for bronchiectasis of years duration. One patient died on the table during the process of separating the lung from the hilus. The second patient did well for a few days postoperative but developed a streptococcic pericarditis from which she died in the second week. Two patients were cured, they are free from cough and expectoration and there are no bronchial fistulas remaining. The technique used was to make a window through the lateral chest wall, and after the lung had been separated to the hilus, clamps were placed around the hilus and the lung cut away. The pedicle was then sutured with chromicized catgut. In his cases the pedicle was so fibrous that this was easy to perform. Hedblom states that the two patients who recovered showed remarkably little constitutional reaction from the operation itself. The operation was performed in two stages, the lung being separated first, since this was the more difficult procedure, and in as much as the lung was thoroughly adherent to the diaphragm. Hedblom also reports that he has performed several partial cauterly pneumectomies for bronchiectatic abscesses with good results.

Brauer (19) stated that total lobectomy was unnecessary and dangerous, and that all that was necessary was

to obtain adequate drainage, and that this could be done by partial resection. This operation calls for the mobilization of the affected lobe. Deep sutures are then placed in order to produce necrosis of the peripheral portion of the lung, and at a subsequent date, the lung is amputated with the paquelin cautery.

Harrington (61) states, " I have done no cases of lobectomies for bronchiectasis as a primary operation. However, I have done six cases following partial or complete surgical collapse. All of these cases had a preliminary phrenicotomy. They were all of a multilocular type of abscess. Two cases of this group died following operation. In the four cases that survived operation, one is entirely healed, and the other three have small bronchial fistulas."

Churchill (30) has presented the following four experiences: (a) Male, age 17, exteriorization lobectomy by temporary paralysis of the phrenic nerve and lower rib resection. Very little of the lobe sloughed off, but the patient has been completely relieved of cough and sputum. A pin-point bronchial fistula opened in the wound after six months of complete closure. During the past year he has had two hemorrhages from this fistula. No discharge and absolutely no sputum.

(b) Male, age 18, Repeated life-endangering hemorrhages from bronchiectasis in the right lower lobe. Two ounces of non-foul sputum. Preliminary phrenicectomy and rib

resection. Lobe freed and diseased portion removed by deep stitches and exteriorization. Result : Wound completely healed and no further hemorrhages.

(c) Male, age 21, repeated hemorrhages and constant three ounces of sputum from the bronchus of the left lower lobe. Preliminary phrenicectomy, single stage lobectomy by primary amputation of the lobe and closure of the stump with deep stitches. Result : No sputum, no bronchial fistulas, small empyema cavity which soon became obliterated.

(d) Male, age 10, Preliminary crushing of the phrenic nerve. Primary amputation of the lobe as in case (c). Result : Two drams of sputum a day in contrast to two ounces of sputum before the operation. Still a residual empyema cavity which is rapidly closing.

At the present time Churchill states that he should elect to do a lobectomy by the following procedures: (a) temporary crushing of the phrenic nerve (b) postural drainage under hospital observation for six weeks (c) exploratory thoracotomy. If the pleural cavity is found obliterated, then to proceed with amputation of the lobe between tourniquets after the method of Shenstone. If a free pleural cavity is encountered, adhesions about the lobe are separated and the pulmonary ligament divided (d) a secondary operation with amputation of the lobe at a later date.

It is usually wiser to consider that anything but a clinical cure following a lobectomy implies that



dilatations and diseased parenchyma still persist. (15).

CONCLUSION

The treatment of bronchiectasis is variable and depends on (a) the etiological factor, (b) the mode of entrance of the invader, (c) the disease present, (d) the location of the disease, and (e) the clinical progress of the patient. (58).

The experience of the physician or the surgeon who has the case, and the financial aid available to the patient, frequently determine the procedure in each case.

Whatever may be the form of treatment, the most important factor must be the consideration of the welfare of the patient, and the most adaptable measures then utilized for each individual case, as the conditions may warrant.

## BIBLIOGRAPHY

- (1) Alexander, John: November 15, 1930: "Treatment of Non-tuberculous Suppurative Pneumonitis, Abscess, and Bronchiectasis.": Journal of the American Medical Association: 95: 20: 1481 - 1483
- (2) Alexander, J.: Personal communication with (15) May 9, 1932.
- (3) Archibald: Personal communication with (15).
- (4) Babcock, W. W.: A Textbook of Surgery: W. B. Saunders Co.: Philadelphia, Pa.: 1930: 931.
- (5) Bailey, R. B.: December 1931: "Non-tuberculous Lung Infection.": The West Virginia Medical Journal: 27: 552 - 554.
- (6) Ballon and Ballon: 1927: Archives of Surgery: 14: 184
- (7) Ballon, D. H.: Archives Otolaryngology: 1926: 3: 403
- (8) Ballon, D. H.: Thoracic Surgery: (In press): Cited by (14).
- (9) Ballon, H., Singer, J.J., Graham, E.A.: December 1931: Bronchiectasis, Etiology: Journal of Thoracic Surgery: Vol. 1: No. "": Pages 154 - 193.
- (10) Ballon, H. C.: 1932: American Journal of Surgery: 15: 1.
- (11) Ballon, H. C.: 1928: Frankfurt, Ztschr. f. Path.: 36: 207: Cited by (14).
- (12) Ballon, H. C.: April 1932: Oleothorax: American Journal of Surgery: 16: 1 - 11.
- (13) Ballon, H., Singer, J.J., Graham, E.A.,: February 1932: Bronchiectasis; Clinical Features and Diagnosis: Journal of Thoracic Surgery: Vol. 1: No. 3: Pages 269 - 325.
- (14) Ballon, H., Singer, J.J., Graham, E.A., April 1932: Bronchiectasis: Treatment: Journal of Thoracic Surgery: Vol.1: No. 4: Pages 397 - 431.

- (15) Ballou, H., Singer, J.J., Graham, E.A., June 1932: Bronchiectasis: Treatment: Journal of Thoracic Surgery: Vol. 1: No. 5
- (16) Bettman, R. B.: 1924: Archives of Surgery: 8: 418: Idem.: Personal Communication with (15) May 16, 1932.
- (17) Black, W.: 1931: Beitr. z. Klin. d. Tuberk.: 78: 638: Cited by (15).
- (18) Boyd, Gladys L.: August 1931: Bronchiectasis in Children: The Canadian Medical Association Journal: 25: 174 - 182.
- (19) Brauer, L.: Cited by Denk.  
Denk, W.D.: 1929: Ztschr. f. chir.: 221: 186.
- (20) Brauer, L.: 1925: Verhandl. d. deutsch Gesellsch. f. inn. med. 37: 95. Cited in (15).
- (21) Brauer, L.: 1908: Therap. d. Gegenw.: 49: 6; Cited in (14).
- (22) Brunn, H. B.: 1929: Archives of Surgery: 18: 490
- (23) Brunn, H. and Fahlkner, W.B., Jr.: February 1929: Bronchiectasis American Review of Tuberculosis: 19: 191 - 200.
- (24) Brunn; Personal communication with (15) on May 16, 1932.
- (25) Bruns, O. and Sauerbruch, F.: 1911: Mitt. Grenzgeb. d. med. u. Chir.: 25: 343: Cited by (15).
- (26) Buckingham, W.W.: 1930: Journal of the American Medical Association: 218 - 237.
- (27) Burrell, Lancelot, S.T.: 1928: Bronchiectasis: "Procedures Interstate Post Graduate Medical Assembly of North America --- Atlanta, Georgia."
- (28) Cabot: Physical Diagnosis, 10th edition: Wm. Wood and Co. Pages 315 - 318.
- (29) Cake, C.P.: February 1931: "Phrenicectomy in the Treatment of suppurative Pulmonary Disease": Virginia Medical Monthly: 57: 750 - 753.

- (30) Churchill, E.W.: May 9th, 1932: Personal Communication with (15).
- (31) Clerf, L. H.: December 1931: "Bronchoscopic Treatment in Bronchiectasis": American Review of Tuberculosis: 24: 609-611.
- (32) Clerf, L. H.: 1927: Archives Otolaryngology: 6: 28:  
Idem.: 1927: Tr. Am. Laryn. Rhin. and Oto.Soc. 33: 387.
- (33) Coquelet, O.: 1929: J. de. Chir. 34: 369: Cited in (15).
- (34) Coryllos, P.N. May 1930: Multiple Stage Lobectomy-- Two cases.": Archives of Surgery: 20: 767 - 801.
- (35) Coryllos, P.N.: May 7, 1932: Personal Communication with (15).
- (36) Curtis, Cole, and Ballou: To be published: Cited by (15).
- (37) Davis, N.: January 31, 1931: "Some recent advances in the treatment of pulmonary disease": Medical Journal of Australia: 1: 136.
- (38) Delafield and Prudden: Fourteenth Edition: Textbook of Pathology: William Wood and Co., Publishers: "Bronchiectasis": Pages 680 - 682: Page 1066.
- (39) de Quervain: 1912: Cor. Bl. f. Schweiz. Aerzte: 64: 356. Cited by (15).
- (40) Deuss, Hugo, O.: July 1932: "The use of iodized oils in Bronchitis and Bronchiectasis: Illinois Medical Journal: 62: 68 - 74.
- (41) Dolly, F.S.: May 16, 1932: Personal communication with (15).
- (42) Dorland: 15th Edition: The American Illustrated Medical Dictionary: Page 211.
- (43) Eloesser, I.: June 1929: "Treatment of Bronchiectasis" Northwest Medicine: 28: 245 - 254.
- (44) Engel, H.: 1924: Handbuch der Kindeheilk, Leipzig: ed. 3, Vogel. Cited by (15).
- (45) Faulkner, Wm. B., Jr.: April, 1931: "Internal Drainage": American Journal of Surgery: 12: 27 - 31.

- (46) Findley, L., and Graham, S.: February 1931: "Prognosis in Bronchiectasis": Archives of the Diseases of Childhood": 6: 1 - 10.
- (47) Flick, J.B.: May 9, 1932: Personal communication with (15).
- (48) Fontaine: 1929: "Oleothorax": Gaston Dion and Co. Paris: Cited by Hayes (63).
- (49) Forbus: 1927: American Review of Tuberculosis: 16: 599.
- (50) Frühwald, F.: 1885: Jahrb. F. Kinderh.: 23: 418. Cited in (15).
- (51) Garre (quoted by Sauerbruch, F.: Chirurgie de Brustorgane, Berlin, Julius Springer: 1920: 1: 586 -587).
- (52) Graham, E.A.: August 1927: "Treatment of Pulmonary Suppuration": Annals of Surgery: 86: 174-181.
- (53) Graham: 1929: Archives of Surgery: 19: 1569.
- (54) Graham, E.A.: Unpublished data, available from (15).
- (55) Graham, E.A.: 1923: Archives of Surgery: 6: 321.
- (56) Graham, E.A.: 1925: January Part 2: Archives of Surgery: 10: 392.
- (57) Guibal, L.: 1924: Bull et mem. Soc. Nat. de Chir: 1: 312: Cited by (15).
- (58) Hamilton, R.L.: July 1930: Canadian Medical Association Journal: 23: 30 - 34.
- (59) Hansen, P.N.: 1917: Norce. med. Ark. Stockholm: 50 Afd. 1.n0 - 13. 1. : Cited in (15).
- (60) Harrington, S.W.: December 1931: "Surgical Treatment of Bronchiectasis and Lung Abscess.": American Review of Tuberculosis: 24: 612 - 625.
- (61) Harrington, S.W.: May 7, 1932: Personal Communication with (14).
- (62) Hasse: 1841: Anatomische Beschreibring der Krankheiten der Circulation und Respirations organe, Leipsig: W. Engleman: Cited in (9).

- (63) Hayes, J.N.: October, 1932: "Dangers and Complications of Oleothorax": Journal of Thoracic Surgery: Vol. II: No. 1: Pages 34 - 43.
- (64) Hedblom: April 29, 1932: Personal communication with (15).
- (65) Hedblom, C.A.: October, 1927: "The diagnosis and treatment of Bronchiectasis": Journal of the American Medical Association: 89: 1384 - 1390.
- (66) Hedblom, C.A.: February, 1931: "Pathogenesis, Diagnosis, and Treatment of Bronchiectasis": Surgery, Gynecology, and Obstetrics: 52: 406 - 417.  
1924: Archives of Surgery: 8: 394.
- (67) Heuter, C.: 1914: Beitr.z. path. Anat. u. z. allg. Path. 59: 520.
- (68) Hitzrot, J.M.: 1920: Annals of Surgery: 71: 785.
- (69) Hoffman, F.A.: 1902: "Disease of the Bronchi, Lungs, and Pleura": (Northnagel's Practice): W.B. Sanders, Co.: Philadelphia and London.
- (70) Jacquet, Roquejeoffre, and Alavoine: 1928: Bull et mem. Soc. Med. de hop. de Paris: 52: 592.  
Cited in (63).
- (71) Küss: 1926: Arch. Med. Chir. de l'app. resp.: 1: 203.  
Rev. de la Tuberc.: 7: 100, 649.  
Ibid: 1928: 9: 714. Cited in (63).
- (72) Lederer: Cited in (9).
- (73) Lilienthal, H.: 1925: Thoracic Surgery; W. B. Sanders Co. Philadelphia and London: 2: 89 - 219.
- (74) Loeb, A. and Michand, L.: 1907: Biochem. Ztschr. Berl. 3: 307.
- (75) Mainzer, F.S.: January 1931: American Journal of Surgery: Vol XI: No. 1: 93 - 95.
- (76) Marchand: 1886: Archives of Pathological Anatomy: 82: 317.
- (77) Marie: 1929: These de Paris: Cited in (63).
- (78) Martin, G.E.: 1929: Diagnosis and Treatment of Bronchiectasis: Edinburg Medical Journal: 36: Pt: 2: 153 - 162.

- (79) Marvin, H. P.: July, 1932: "Chronic Bronchiectasis":  
The Military Surgeon: 71: 1.
- (80) McCrae, T. and Funk, E.H.: 1916: Journal of the  
American Medical Association: 67: 1060.
- (81) McNeil, C., MacGregor, A., and Alexander, W.A.: 1929:  
"Studies of Pneumonia in Childhood -- Bronchiec-  
tasis": Archives of Diseases of Children:  
4: 170 - 182.
- (82) Meyer, W.: 1917: Annals of Surgery: 66: 602.
- (83) Nelson's Loose-leaf System of Medicine: 3: 446 - 452.
- (84) Naegeli, T.: 1923: Ztsch. f. Aertzl. Fortbild: 20:  
193: Cited by (15).
- (85) Nissen, R.: 1931: Zentralbl. f. Chir. 47: 3,003.  
Cited by (15).
- (86) Norris and Landis: 1929: "Diseases of the Chest and  
the Principles of Physical Diagnosis.": W.B.  
Saunders Co. Philadelphia and London: Edition 4.
- (87) Oakley, W. G.: August 29, 1931: "Indications for  
Phrenic Avulsion in Bronchiectasis": British  
Medical Journal: 2: 378 - 381.
- (88) Ochsner, A.: August, 1930: "Use of Iodized Oils in  
Bronchiectasis": Surgical Clinics of North  
America: 10: 843 - 849.
- (89) Ochsner, A.: 1930: American Journal of Medical Sciences:  
179: 388 - 405.
- (90) Osler: Eleventh Edition - McCrae: The Principles and  
Practice of Medicine: D. Appleton and Co.:  
Page 630.
- (91) Pinchin, A.J.S. and Morlock, H. J.: November 15, 1930:  
Cauterization of Adhesions in the Treatment of  
Bronchiectasis by Artificial Pneumothorax":  
Lancet: 1070.
- (92) Quinn, I.H. and Meyer, O.O.: August, 1929: "The Re-  
lationship of Sinusitis and Bronchiectasis.":  
Archives of Otolaryngology: 10: 152 - 165.
- (93) Rivière, Clive: November 27, 1926: Lancet: 1102 -  
1106.

- (94) Robinson, S.: 1917: Surgery, Gynecology, and Obstetrics: 24: 194. —Also Personal Communication with (15).
- (95) Rokitansky, C.: 1896: Allg. Wien. med. Ztg.: 41: 243, 255, 268, 280, 293. Cited in (9).
- (96) Rokitansky, C.: 1842: Lehrbuch. der Pathol. Anatomie, Wien: 3: Braumuller u Seidel. Cited in (9).
- (97) Sauerbruch, F.: 1920: Die Chirurgie der Brustorgane: Berlin: 1: 580: Julius Springer.
- (98) Sergent, Emile: June, 1926: International Clinic: 2:20
- (99) Shenstone, N.S.: August, 1932: "Pulmonary Lobectomy": The Canadian Medical Association Journal: 27: 128 - 145.
- (100) Shenstone, N.S.: May 19, 1932: Personal Communication with (15).
- (101) Siegmund, H.: 1922: Virchows Arch. F. Path. Anat.: 236; 191. Cited by (14).
- (102) Singer, J. J.: 1928: American Review of Tuberculosis: 18: 438.
- (103) Singer, J.J.: --- Unpublished Bata.
- (104) Singer, J.J. and Graham, E.A.: 1926: "Roentgen-Ray study of Bronchiectasis": American Journal of Roentgenology: 15: 54 - 58.
- (105) Singer, J.J. and Graham, E.A.: "Clinical Demonstration of Bronchiectasis": Archives of Surgery: 19: 2: 1559 - 1561
- (106) Singer, J.J. and Ballou, H.C.: 1930: American Review of Tuberculosis: 22: 233.
- (107) Smith, D.T.: December, 1930: Archives of Surgery: 21; Pt. 2: 1173 -1187.
- (108) Smith, J.K.: August, 1929: "Surgical Treatment of Bronchiectasis: The Journal of the Arkansas Medical Society: 26 - 27: 63 - 65.
- (109) Steihm, R. H. October, 1930: "Treatment of Bronchiectasis with lipiodol with Report of 9 cases": Wisconsin Medical Journal: 29: 556 - 562.



- (110) Stitt, H.L.: 1923: Bulletin St. Louis Medical Society:  
26: 246.
- (111) Swann, W.C.: June, 1930: "Discussion of Ipiodol in  
Bronchiectasis": The West Virginia Medical Jour-  
nal: 26: 337 - 338.
- (112) Thorpe, E.S., Jr.: June, 1929: "Chronic Bronchiectasis  
in Childhood with Observations on Early Diagnosis":  
American Journal of the Medical Sciences: 177:759-767.
- (113) Todd and Sanford.: 1930 : Clinical Diagnosis by Laborat-  
ory Methods : W.B.Saunders Co.: Page 81.
- (114) Turner, G.: May, 1928: "Diagnosis and Treatment of  
Bronchiectasis by the Injection of Ipiodol"..:  
Southwestern Medicine: 12: 206 - 209.
- (115) Weinberg, J.: 1933 : Personal Communication.
- (116) Whitaker, P.F. : "Bronchiectasis" : July, 1930 : Virginia  
Medical Monthly : 57: 233 - 236.
- (117) Whittemore, W., and Balboni, G.M. : 1928 : Archives  
of Surgery : 60 : 228:.
- (118) Whittemore, W. : 1927 : Annals of Surgery : 86 : 219-226.  
"Treatment of Such Chronic cases of Bronchiectasis,  
as are Limited to One Lobe."
- Whittemore, W. : 1927 : "Treatment of Chronic Bronchiectasis"  
Boston Medical and Science Journal : 196: 182-184.
- Whittemore, W. : September 24, 1931.: New England Journal  
of Medicine.: 205 : 629 - 632.
- (119) Whittemore, W. : May 2, 1932. : Personal Communication  
with (15).
- (120) Wiese, O., : 1930 : Beitr. z. Klin. d. tuberk.: 75 : 195.  
Cited in (15).
- (121) Wilson, H. : 1930 : Medical Journal of Australia : 2: 487.
- (122) Wooding, C.E. : 1932 : Bulletin of the St.Louis Medical  
Society. : 26 : 249 :
- (123) Zaaijer, I.H. : 1927: Deutsch. Ztschr. f. Chir. : 200: 170.  
Cited in (15).