OBSERVATIONS CONCERNING THE CONTRALATERAL LUNG IN PULMONARY TUBERCULOSIS TREATED BY ARTIFICIAL PNEUMOTHORAX

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OBSERVATIONS CONCERNING THE CONTRALATERAL LUNG IN PULMONARY TUBERCULOSIS TREATED BY ARTIFICIAL PNEUMOTHORAX[1]

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The indications and contraindications for collapse therapy seem to be fairly well defined, as far as the "worse diseased lung" is concerned, at least in the minds of most of the men who are practising the treatment. There is, however, a wide divergence of opinion as far as the opposite lung is concerned, particularly as to the amount and character of disease which will permit a collapse with safety and a successful issue.

Considering this great diversity of opinion regarding the indications and contraindications for artificial pneumothorax as far as the contralateral lung is concerned, we have deemed it pertinent to present our observations which have been carried on in the period, 1911 to 1923, during which time 600 cases of pulmonary tuberculosis were subjected to artificial-pneumothorax treatment.

This study has to do only with the chronic types of tuberculosis, particularly with the fibrocaseous and fibrocaseous cavernous groups, 423 cases, for the reason that they lend themselves to longer continued observations, and therefore more accurate conclusions, than the acute forms of tuberculosis and those cases in which the collapse was done only as a palliative procedure, to control severe symptoms, hemoptysis, etc.

The 423 cases in which collapse was attempted or carried out were classified into the groups given in table 1. According to the N. T. A. Classification, 358 cases were far advanced and 65 cases were moderately advanced.

TABLE 1

	CASES
Chronic fibrocaseous tuberculosis, progressive, with little or no demonstrable excavation	194
Chronic fibrocaseous cavernous tuberculosis, progressive	177
Chronic fibrocaseous cavernous tuberculosis with cavity manifestations in the foreground	52

[1] Read at the Twentieth Annual Meeting of the National Tuberculosis Association, Atlanta, Georgia, May 8, 1924.

The end-results of pneumothorax therapy are so intimately associated with and dependent upon the behavior of the contralateral lung, that, if accurate deductions based upon a comparison of end-results are to be made, it is essential that a classification of the status of the opposite lung be adopted. In this way one will be able to estimate, with a fairer degree of accuracy, the prognostic significance of the various types of contralateral lung disease before subjecting the patient to collapse therapy. While we realize that many types of pathological change may coexist in the opposite lung, those cases which we subjected to pneumothorax usually presented a dominant type which we classified as shown in table 2.

TABLE 2

	CASES
Essentially negative	97
Deep peribronchial infiltration	103
Disseminated bronchogenic caseous extensions	40
Active fibrocaseous infiltration	134
Quiescent fibrocaseous infiltration	49

DESCRIPTION OF CLASSIFICATION

1. Essentially negative: It is frequently difficult, if not impossible, to demonstrate hidden or obscure foci of infection in the contralateral lung, but in the cases which we have classified as *Essentially Negative* the physical and roentgenological findings were well within the limits of normal disparity.

2. Deep peribronchial infiltration: The physical examination is as a rule negative, aside from questionable alterations in breath-tones, with an entire absence of moisture. The diagnosis of this lesion is based largely upon roentgenological findings, and is characterized by a marked increase in the shadows of all or parts of the bronchial tree, especially of those shadows radiating from the hilum toward the superficies.

These shadows usually present an irregular, beady or varicose arborization, with fuzzy or clear-cut borders, depending upon the age and activity of the lesion.

In view of the presence of an active tuberculosis in the other lung, roentgenological findings of this character justify the diagnosis of deep peribronchial infiltrations, undoubtedly tuberculous.

The peribronchial type of tuberculous infiltration *per se*, from a standpoint of pneumothorax therapy, does not require great consideration as long as it remains confined to the peribronchial structures.

These infiltrations are not always benign in character, for in lesions of this type there is a tendency to invasion of lung parenchyma, and when this occurs it becomes a matter of serious import, especially when happening during the course of pneumothorax therapy.

Invasion of lung parenchyma is usually readily demonstrable by physical diagnostic methods and its evolution may be watched by the study of serial plates.

3. Disseminated bronchogenic caseous extensions: These lesions, so constant in the study of gross pathological changes, usually occur as a result of the aspiration of bacilli-laden sputum into the contralateral lung, and are characterized by the presence of localized caseous pneumonic, caseous bronchopneumonic and disseminated confluent tuberculous infiltrations, frequently associated with a tuberculous bronchitis. These bronchogenic extensions usually take place into the dependent portions of the lung or into the perihilar region. Roentgenologically, they are revealed as disseminated patches of increased density, corresponding to the distribution of the lesions and varying in character according to the activity or inactivity of the process. If deep-seated, they may escape physical diagnostic procedures, but if superficial they are readily recognized by the continual presence of moisture and alterations in breath-tones.

4 and 5. Active and quiescent fibrocaseous infiltrations: These lesions, in contradistinction to the bronchogenic infections above described, usually occupy the upper half of the lung. They are readily recognized by the usual physical diagnostic and roentgenological procedures, although there is a frequent disproportion between physical and roentgenological findings, and to place sole reliance upon one or the other alone will frequently lead one astray. The activity or inactivity of the process is determined by a correlation of these findings. As a rule, the presence of moisture indicates activity, although its absence by no means indicates quiescence.

Moisture, when present, must be carefully studied in order to determine its pathological significance. An effort should be made to elicit and to differentiate those râles characteristic of fresh invasion or destructive lesions, from those associated with an obsolete or retrogressive process. Râles which occur in the form of fine showers on deep inspira-

tion or on expiratory cough almost invariably indicate fresh invasion. Destructive lesions are usually associated with abundant râles which are more or less numerous, according to the rapidity of the process. They possess a resonating or metallic quality and they vary in character according to the character of the excavation from which they arise. Retrogressive or stationary lesions are more often associated with râles of a nonresonating character, are less numerous and are best elicited on the first inspiration following expiratory cough.

Retrogressive and healed lesions are accompanied by fibrosis which causes dilatation of terminal bronchioles. Even excavated areas may heal and become lined with a mucosa; thus, the tuberculous process, as such, really no longer exists.

These changes may be associated with abundant râles which are more or less persistent, but one should be familiar with their pathological significance and not be confused by their presence, as they are evidences of an obsolete or healed lesion. When these changes are encountered over a small localized area, collapse of the opposite lung is not always contraindicated.

Râles arising as a result of adhesive pleuritis and atelectasis can be readily confused with râles of great significance. Râles associated with an adhesive pleuritis occur as superficial crackles, best heard on forced respiratory movement, and they do not appear in the form of showers on expiratory cough. Atelectatic crackles are usually heard along the margin of the lung. These crackles disappear after a few inspirations and are never persistently present in the same location day after day.

The fibrocaseous lesions present fairly characteristic roentgenological markings. The roentgenograph will supply evidence tending to prove the age of the lesion and, in a measure, also the activity or inactivity of the process. Early infiltrative lesions may escape roentgenological recognition, and are at times best recognized stethoscopically.

The more active and progressive lesions are characterized by patch-like spots with indefinite irregular borders, whereas the quiescent and retrogressive processes are represented by more linear markings with more sharply circumscribed borders.

As a rule, auscultation will elicit exaggeration in breath-tones, both in the active and quiescent lesions. One must carefully differentiate, however, that type of exaggerated breathing heard over fresh invasion from the compensatory type of breathing so frequently heard in the contralateral lung.

SELECTION OF MATERIAL AND CONTROL OF TREATMENT

The recognition, interpretation and classification of these various lesions in the opposite lung are of paramount importance in the selection of material, and great caution should prevail in their treatment.

Early in our work we were loath to subject to pneumothorax therapy any case presenting more than minimal traces of disease in the contralateral lung, except as a last resort.

As a result of the observations made during the treatment of some of these last-resort cases, we realized that not infrequently excellent results, occasionally leading to complete recovery, could be obtained, even in the presence of extensive disease in the opposite lung. The results, however, were dependent upon many factors, such as the character of collapse, flexibility of mediastinum, type of opposite lung lesion, and vigilance exercised as to changes taking place therein.

We have observed that a diseased lung varies greatly in its reaction to collapse of the other side; and we have learned that certain types of contralateral lung disease can be approached with relative safety, while other types are approached with great reluctance and apprehension.

As a general rule the fibrocaseous lesions involving the apex or upper portion of the lung react much more favorably than the fibrocaseous lesions located around the root of the lung, or the bronchogenic caseous extensions scattered throughout the lower portions of the lung.

This difference in reaction may be due to the fact that upper-lobe lesions are more firmly immobilized by fibrosis and pleuritic thickening, and are usually favored with better drainage, while lower-lobe lesions are unfavorably influenced by being subjected to greater amplitude of respiratory motion, which inhibits fixation and favors aspiration and dissemination, which are further enhanced by poorer drainage.

Furthermore, certain types of lesions, especially those in the perihilar region, are kept in constant motion by cardiac activity, which the fluoroscope will readily reveal as a constant tugging and pulling that are synchronous with each heart-beat.

All patients reported in this series received sanatorium treatment, many of them having been under observation for long periods of time, and had exhausted various climatic, dietetic, and hygienic procedures. The delay in treatment in many cases was very unfortunate, because when we were obliged to resort to an artificial pneumothorax, we were unable to introduce gas on account of the presence of adhesions. Of

recent years we have felt that, if after a brief period of observation, one to three months, any doubt exists as to the favorable outcome by the usual sanatorium regimen, collapse therapy should be immediately instituted if no contraindications exist. This is particularly imperative in cavity cases with abundant expectoration, in which there exists constant danger of infection, not only of the opposite lung by aspiration, but of the bowel through deglutition, and of the larynx through lodgment of sputum.

Any procedure which has for its object the reduction of sputum quantity, thus lessening the danger of these complications, is justifiable; and we have felt that our tardiness in utilizing pneumothorax treatment was responsible for many failures, through the development of these various complications.

Notwithstanding the danger of delay, if the contralateral lung lesion is very active, it is better to allow the activity of the process to subside somewhat before resorting to collapse, but this furthermore enhances the danger of the formation of adhesions. If the disease in the contralateral lung is not too active, this danger can be minimized by interposing a thin layer of gas, thus separating the worse diseased lung from the chest-wall to the extent of an inch or two, and then maintaining this character of collapse while observing the behavior of the opposite lung. Frequently we have noted the beneficial effects of these small degrees of collapse, not only in the worse diseased lung, but also in the contralateral lung, particularly in the fibrocaseous lesions involving the upper portion. By this manner of approach we have, in many cases, been enabled to bring about a gradual satisfactory collapse of the worse diseased lung with an uninterrupted improvement of the opposite lung process, even leading to complete recovery. In some cases, collapse has been carried out for years without any appreciable influence on the opposite lung process. In other cases, in spite of our watchfulness and care, progression of disease took place in the opposite lung. In still other cases the contralateral lung lesion remained stationary for years, later on becoming rapidly progressive and demanding a pneumothorax.

During the period of sanatorium treatment all patients were taught a method of chart-keeping, whereby the temperature and pulse were recorded in a graphic manner, and the charts were continued during the whole course of their pneumothorax treatment. They were also made acquainted with the extent and character of their disease, results of all examinations and the principles of pneumothorax treatment, thus

enabling them to render more intelligent coöperation. All or most cases were discharged to ambulant care at the earliest possible moment compatible with safety.

Having established the indications for collapse therapy as far as the worse diseased lung is concerned, there still remains the important task of estimating the integrity of the opposite lung, for, after instituting a pneumothorax, one will frequently be confronted with the problem of having to decide whether or not unfavorable symptoms are emanating therefrom.

A solution of this problem will be greatly facilitated by always maintaining accurate records of the status of the contralateral lung. These records should contain the exact topographical distribution of physical findings recorded before each inflation, and as often as necessary during the interval. Râles, if present, should be studied and the following points carefully noted: Whether they appear only on expiratory cough or on first inspiration following, or whether they are present on ordinary breathing. Their character, amount and exact anatomic distribution should be recorded, so that the record can be compared with all previous examinations.

The roentgenological control must be carried out with great frequency. It is our custom to make a fluoroscopic examination from which an orthodiagram is prepared, before each inflation, and during the early phases of the collapse it is imperative to resort to the fluoroscope more frequently, in order to determine better the proper interval for inflation.

Each individual patient is a law to himself as far as reaction of the lung to inflation and absorbability of gas are concerned, and difficulties will be encountered sooner or later if a fixed plan is adopted as to the time interval and as to the amount of gas introduced. By the frequent recourse to the fluoroscope, one will be better able to adapt oneself to these varying factors which each patient may present.

Unless the use of the fluoroscope is resorted to freely, the integrity of the contralateral lung may be threatened after the first few inflations through undue stress placed upon it by great displacement of mediastinal contents, which might otherwise easily escape detection. One should not depend solely upon manometric pressure readings and physical findings to determine the character of collapse.

In the roentgenological control of the contralateral lung the fluoroscope alone is inadequate, and one must depend upon frequent use of films for

the reason that early fresh invasions escape fluoroscopic detection, even if roentgenologically present.

Too much reliance should not be placed upon the examination of a single film in any case, presenting actual or threatened invasion of the opposite lung; but the last film should be minutely compared with the previous films, for it is possible only in this manner to evaluate the exact changes taking place. In the interpretation of the markings in the contralateral lung, one must differentiate between actual pathological changes and changes due to circulatory stasis, which are especially marked in cases presenting a bulging mediastinum.

In doubtful cases the differentiation is facilitated by permitting a slight reëxpansion of the collapsed lung, thus allowing the mediastinum to assume a more normal position, when the shadows due to circulatory disturbance rapidly disappear.

Disease in the contralateral lung is best revealed on films taken at the height of deep inspiration, but changes in the position of the mediastinum are best seen in films taken at the end of expiration. By comparison of the films taken in these two positions it is interesting to note the great excursion which can taken place in a labile mediastinum.

X-ray films have the distinct advantage of supplying a permanent record.

During the early phases of collapse therapy, films should be made after every third or fifth inflation if one resorts to small amounts of gas at short intervals, and later on, after the first two or three months, films should be made at monthly intervals. Ambulant cases are "filmed" at least once every three months throughout the whole course of their treatment.

In the selection of material, and in the control of treatment, one always has to contend with the transmission of auscultatory findings from the worse diseased lung to the opposite side. From a physical diagnostic standpoint alone, it will be exceedingly difficult to differentiate these transmitted auscultatory phenomena from those due to actual disease, but an endeavor should be made to find out their source, by localizing their point of maximum intensity and, in the case of transmitted phenomena, one will be led to the opposite lung. A decision will be further facilitated by a study of X-ray films, which will reveal an entire absence of disease in the contralateral lung that could account for the character of the auscultatory findings. The flexibility of the mediastinum will also have an important bearing on adventitious sounds elicited

in the contralateral lung, for occasionally râles, when present in the opposite lung before inflation, will change in character, or disappear immediately afterward, in the presence of a flexible mediastinum.

ANALYSIS OF CLINICAL PHENOMENA

In the presence of actual or threatened invasion of the opposite lung, one is continually confronted with the task of having to exclude the contralateral lung as a source of any unfavorable clinical signs or symptoms, the most serious of which are the following: fever, increased expectoration and hemoptysis.

Febrile reaction following inflation, or the regular occurrence of an ephemeral exacerbation of temperature within twenty-four hours after inflation in the presence of a satisfactory collapse, should lead one to suspect the opposite lung, particularly in the absence of an exudate or of adhesions.

Recurrence of fever following an afebrile period occurs most commonly under the following conditions: appearance of exudate in pneumothorax cavity, insufficient collapse, that is, reëxpansion of lung, progression or extension of disease in contralateral lung, extrapulmonary tuberculous complications, especially enteritis, and acute nontuberculous respiratory infections.

Fluoroscopy alone will suffice to reveal an exudate and aspiration will usually cause subsidence of fever.

Difficulty will at times arise in differentiating fever, due to progression or extension of disease in the contralateral lung, from fever due to insufficient collapse, that is, reëxpansion of lung.

A solution of this question is exceedingly important, for to be misled at this juncture might convert a possible successful end-result into a failure. If the fever is due to reëxpansion, a delay in inflation will permit further progression of disease in the collapsed lung, and it also involves the danger of an early obliterative pneumothorax. If the fever is due to progression or extension of disease in the contralateral lung, further compression would only aggravate this disease already present. In arriving at a decision, the contralateral lung must be subjected to a searching examination, the results of which must be minutely compared with the records of previous examinations (films and physical). If, after this comparison, there is no evidence of fresh invasion or progression of disease in the opposite lung, then further collapse is justifiable.

Fever due to extrapulmonary tuberculous complications is usually

associated with localizing symptoms, which develop coincidently with or shortly after the febrile reaction, and is uninfluenced by inflation. Fever of this character may be due to an obscure tuberculous enteritis, from which the patient complains of no subjective symptoms or only of mild gastrointestinal disorder. The cause of the fever may escape detection unless especially sought for, particularly in the presence of contralateral lung disease which is always to be suspected. As a rule, contralateral lung disease will be excluded as an etiological factor in the production of the fever, as here again the inflations will have no relationship to the remissions and exacerbations of the irregular type of fever which is present in tuberculous enteritis. An ischiorectal abscess, acute or chronic, can at times account for this type of fever.

Fever due to acute infections may be confusing during the period of its onset; and, until the localizing symptoms appear, one will be led to suspect the contralateral lung, especially if it is already diseased. The most common of these are the acute infections of the upper respiratory tract, tonsils, sinuses and teeth.

Fever which is continuous in spite of apparently satisfactory collapse, such as minor degrees of continuous fever, 99 to 99.6°, is occasionally encountered in patients who are otherwise apparently clinically well. This type of fever is at times very annoying to the patient, as well as to the physician, and for a time the cause escapes detection. It must be borne in mind that this type of fever is not always due to the tuberculous process itself, but it may be due to nontuberculous complications, such as chronic focal infections, thyrotoxicosis, etc., which not uncommonly coexist in the tuberculous patient.

There is, however, this distinction: that when the fever is due to tuberculosis it is more responsive to rest and more aggravated by exercise, whereas the fever due to a nontuberculous process is not influenced to such an extent. When fever of this type is due to contralateral lung disease, it is usually associated with other evidence of a clinical, physical diagnostic or roentgenological nature, which will be revealed after sufficient observation.

Another type of continuous fever encountered is that in which treatment has been associated with a reduction of fever amounting to two or more degrees, but there still remains an average daily maximum of 100.6° in spite of a satisfactory collapse. When temperature of this character is due solely to contralateral lung disease, auscultation alone will usually supply ample evidence of its origin.

INFLUENCE OF CONTRALATERAL LUNG DISEASE ON SPUTUM

Of equal importance in eliminating the contralateral lung as a factor in the causation of fever is its elimination as a source of bacilli-laden sputum, in the presence of a collapse of the worse diseased lung.

The persistence of bacilli-laden sputum, with an essentially negative contralateral lung and in the presence of an *apparently* satisfactory collapse, indicates that diseased tissue is not sufficiently collapsed, either because of the presence of adhesions, particularly apical, which are not always revealed by X-ray films, or because of the presence of rigid-wall excavations. However, the persistence of bacilli-laden sputum in quantities of 20 or 25 cc. daily, in the presence of a diseased contralateral lung and with an *apparently* satisfactory collapse of the worse diseased side, should lead one to strongly suspect the contralateral lung as a source, particularly when auscultation reveals moisture in it.

Under these circumstances one will be obliged to decide whether to allow of moderate reëxpansion, thus relieving the contralateral lung, or to further collapse the worse diseased lung. When confronted with this problem, it is essential that the twenty-four-hour quantity of sputum should be measured carefully each day, and its relationship to inflation and physical findings in each lung closely observed.

The influence of inflations on the temperature curve should be observed as well, for, in the presence of contralateral lung disease, inflations are sometimes followed by an exacerbation of temperature, which, when associated with an increase in sputum amount, points more strongly to the contralateral lung as a source.

If the contralateral lung is responsible for the increased expectoration, the physical examination will usually reveal an increase in the amount of râles, as well as an increase in their distribution, when compared with previous examinations.

Stereoscopic films should be made, and these should be carefully compared with all previous films, and if the contralateral lung is to blame for the sputum increase corroborative evidence will usually be manifest as a progression of disease.

The influence of the patient's bed posture during coughing paroxysms and lung drainage should be carefully observed, as much valuable evidence may be supplied that may tend to show the side from which the sputum emanates, as some positions will be associated with freedom from cough and expectoration, due to retention of secretion in dependent por-

tions of the lung, whereas other positions will provoke coughing paroxysms with abundant expectoration due to free drainage.

A final decision can best be reached only after a correlation of all findings.

HEMOPTYSIS

Severe hemoptysis occurs at times in the course of pneumothorax treatment, and always directs attention to the contralateral lung, particularly if it is diseased. In a series of 480 collapsed cases (all types of tuberculosis) severe hemoptysis was present preceding or shortly before pneumothorax treatment was begun in 82 cases, but after pneumothorax treatment was instituted hemoptysis occurred in only 10 cases.

It is notoriously difficult to determine from which side bleeding is having its source, particularly when one is dealing with a diseased contralateral lung, but the accurate determination of this point is imperative, for if the bleeding is proceeding from the collapsed lung, further collapse is demanded; while if from the opposite lung, further collapse is strongly contraindicated. The determination of the bleeding side is complicated by reason of the hesitancy in submitting the patient to a searching physical examination in the presence of active bleeding. Much valuable information will be obtained from the patient's own statement regarding certain subjective phenomena which he has experienced immediately before or very early during the hemoptysis. These sensations are commonly described as a sense of tightness, constriction, pain, "rattling," or "fluttering," the exact location of which the patient will indicate with absolute confidence and assurance. These statements may be misleading, but they are, nevertheless, deserving of consideration.

As a result of bleeding, aspiration of blood occurs into dependent portions of the lung, and it is always more extensive on the bleeding side. The presence of this blood will furnish auscultatory evidence in the form of râles which are quite characteristic, and may be readily heard in portions of the lung into which aspiration has taken place. These râles have been variously described as "medium" or "small bubbling," or "crackles." At first they are nonresonating and only become resonating later on, with the development of consolidation.

COMPARATIVE SIGNIFICANCE OF THE VARIOUS TYPES OF CONTRALATERAL LUNG LESIONS BASED UPON END-RESULTS

A valuable aid in the selection of material and in determining the indications for collapse will be furnished by a comparison of end-results in the various types of contralateral lung lesions, whereby one will be able to judge the prognostic significance of disease in the contralateral lung, with collapse of the worse diseased side.

TABLE 3

End-results in 423 cases of fibrocaseous and fibrocaseous cavernous tuberculosis

STATUS OF CONTRALATERAL LUNG	NUMBER OF CASES	CHARACTER OF COLLAPSE	NUMBER OF CASES	CLINICALLY WELL		ARRESTED		DEAD	
				Number	Per cent	Number	Per cent	Number	Per cent
Essentially negative	97	Satisfactory	56	29	52	11	20	8	14
		Partial	25	10	40	1	4	6	24
		No free space	16	4	25	1	6	9	56
Deep peribronchial infiltration	103	Satisfactory	49	24	45	12	24	10	20
		Partial	33	3	9	7	21	20	60
		No free space	21	1	4	3	13	9	43
Disseminated bronchogenic caseous extension	40	Satisfactory	15	4	26	4	26	5	33
		Partial	21	1	4	5	24	14	66
		No free space	4	0	0	0	0	3	75
Active fibrocaseous infiltration	134	Satisfactory	50	24	48	11	22	11	22
		Partial	59	4	6	12	20	27	46
		No free space	25	0	0	3	12	19	76
Quiescent fibrocaseous infiltration	49	Satisfactory	21	10	50	5	24	4	20
		Partial	16	4	25	6	37	6	37
		No free space	12	2	16	2	16	4	33
	423		423	120		78		155	

A study of the table of end-results (table 3), with a view of determining the significance of the contralateral lung lesions, will reveal that of the 423 cases subjected to artificial-pneumothorax treatment, 326 cases had demonstrable disease in the opposite lung, and in 223 of these it amounted to well-defined fibrocaseous infiltrations or disseminated bronchogenic extensions. It will be seen that only 23 per cent of the cases included in this series presented an essentially negative contralateral lung.

The "No Free Pleural Space" cases have been included in this series for the reason that they serve as invaluable controls; for, aside from the fact that they received no pneumothorax treatment, their treatment was identically the same in every other respect.

The inclusion of the "No Free Pleural Space" cases is also important because a study of table 3 will reveal that satisfatory end-results are as much dependent upon the presence of free pleural space and the character of collapse attained as they are upon the presence or absence of disease in the opposite lung.

Of the 423 cases, 97 had an "Essentially Negative" opposite lung. Of this number, 56 secured a satisfactory collapse, of which 52 per cent are clinically well, 20 per cent are arrested and 14 per cent are dead.

Of the 423 cases, 103 had a deep peribronchial infiltration in the opposite lung. Of this number, 49 received a satisfactory collapse, of which 45 per cent are clinically well, 24 per cent are arrested and 20 per cent are dead.

It will be noted in comparing the deep peribronchial infiltration with the essentially negative contralateral lung, that in the presence of a satisfactory collapse there are 7 per cent less clinically well and 6 per cent more dead in the former than there are in the latter group.

Of the 423 cases, 40 cases had disseminated bronchogenic caseous extensions in the opposite lung. Of this number, 15 received a satisfactory collapse, of which 26 per cent are clinically well, 26 per cent are arrested and 33 per cent are dead.

Thus, from a prognostic standpoint, this type of contralateral lung lesion is of serious import; for, when compared with the essentially negative contralateral lung group, it will be seen that there are 26 per cent less clinically well and 19 per cent more dead in the former than in the latter group.

Of the 423 cases, 134 had an active fibrocaseous infiltration in the opposite lung. Of this number, 50 received a satisfactory collapse, of which 48 per cent are clinically well, 22 per cent are arrested and 22 per cent are dead.

In comparing this type of contralateral lung with the essentially negative opposite lung, it will be observed that there are only 4 per cent fewer cases clinically well, but there are 8 per cent more dead.

Of the 423 cases, 49 had a quiescent fibrocaseous infiltration in the opposite lung. Of this number, 21 received a satisfactory collapse, of which 50 per cent are clinically well, 24 per cent are arrested and 20 per cent are dead.

In comparing the active with the quiescent fibrocaseous infiltrations, it will be seen that there are 2 per cent more clinically well, 2 per cent more arrested and 2 per cent less dead in the quiescent than in the active fibrocaseous groups.

This difference in end-results is not as great as one would expect in a comparison of an active with a quiescent fibrocaseous opposite lung, but it is probable that activity undoubtedly existed in some cases which we were obliged to classify as quiescent because of our inability to demonstrate activity, even though it was suspected. However, these figures are entirely consistent when one compares the end-results (table 4) in both the active and quiescent fibrocaseous opposite lung lesions, with the essentially negative contralateral lung.

TABLE 4

Comparison of end-results in active and quiescent fibrocaseous contralateral lung with essentially negative contralateral lung in presence of a satisfactory collapse

STATUS OF CONTRALATERAL LUNG	CLINICALLY WELL	ARRESTED	DEAD
	per cent	*per cent*	*per cent*
Essentially negative	52	20	14
Quiescent fibrocaseous infiltration	50	24	20
Active fibrocaseous infiltration	48	22	22

As previously stated, the disseminated bronchogenic caseous extensions, occupying the perihilar and lower portions of the lung, offer a much more unfavorable outlook than the fibrocaseous lesions usually occupying the upper portions of the lung.

A study of end-results in the following table (table 5) will reveal that the disseminated bronchogenic caseous extensions are the most serious type of contralateral lung lesions with which we have had to deal.

TABLE 5

Comparison of end-results: essentially negative with certain types of contralateral lung disease in the presence of a satisfactory collapse

STATUS OF CONTRALATERAL LUNG	CLINICALLY WELL	DEAD
	per cent	*per cent*
Essentially negative	52	14
Active fibrocaseous infiltration	48	22
Quiescent fibrocaseous infiltration	50	20
Disseminated bronchogenic caseous extensions	26	33

From a study of the above statistics, as regards the percentage clinically well and dead in the presence of a satisfactory collapse, it might be held by some that results equally satisfactory are attained by the usual sanatorium regimen without pneumothorax.

However, the value of pneumothorax therapy in this series will be clearly shown by a comparison of the end-results in cases satisfactorily collapsed (table 5) with those having "No Free Pleural Space," which serve as controls (table 6).

TABLE 6

End-results in noncollapsed cases (no free pleural space)

STATUS OF CONTRALATERAL LUNG	CLINICALLY WELL	DEAD
	per cent	*per cent*
Essentially negative	25	56
Active fibrocaseous infiltrations	0	76
Quiescent fibrocaseous infiltrations	16	33
Disseminated bronchogenic caseous extensions	0	75

It will be observed that in this series, from a study of table 3, a patient's opportunity for recovery was much better with any type of contralateral lung disease in the presence of a satisfactory collapse than in the case of the patient who had an essentially negative lung, in which collapse was not possible on account of our inability to find a free pleural space.

OBSERVATIONS ON PROGRESSION AND EXTENSION OF DISEASE IN CONTRALATERAL LUNG

The term "Progression of Disease" refers to those cases in which there was exacerbation of disease in a contralateral lung already diseased, whereas the term "Extension of Disease" refers to those in which invasion of an essentially negative contralateral lung took place.

In compiling our statistics we have included in our figures only those instances of progression or extension of disease in the contralateral lung, in which these complications occurred during the actual period of pneumothorax treatment.

Undoubtedly progression and extension of disease took place in the terminal phases of many cases after pneumothorax treatment was abandoned, particularly in the progressively fatal cases, but they were not included for the reason that the development of these complications was not associated with or related to the period of collapse therapy.

No doubt, minor degrees of progression and extension of disease took place in some cases, but it was of a character which escaped physical diagnostic or roentgenological methods of recognition.

It is also true that many cases experienced alternating periods of exacerbation and quiescence of activity of contralateral lung disease while under collapse, but the periods of exacerbation were temporary and were not of a character demanding discontinuance of collapse therapy.

Whether these exacerbations occurred in spite of, or were dependent upon collapse, is impossible to say, because changes of this nature are not infrequent throughout the course of any tuberculous process.

When progression of disease in the opposite lung is of a mild nature, a prolongation of intervals and the introduction of small amounts of gas are necessary, thus permitting of some reëxpansion of the collapsed lung, which will frequently bring about a subsidence of the activity in the contralateral lung and a coincident improvement.

Severe and rapid progression of disease in the contralateral lung demands temporary cessation of pneumothorax treatment. Under circumstances of this nature, one will be confronted with a complicated problem to decide upon future procedure. A decision will be reached after a brief period of observation, and one will be guided in this decision by the behavior of both lungs during this period.

When reëxpansion of the collapsed lung is not followed by reactivation of disease therein, one will be justified in considering the feasibility of bilateral collapse. Should this procedure be adopted, the primarily collapsed lung should be permitted to reëxpand as much as possible without evidence of reactivation of disease in it, and at the same time it must still be under control, so that recollapse can be instituted as indications require. If no reactivation occurs, one can then proceed cautiously with the contralateral lung collapse. The inflations should then be made alternately, the intervals and amounts of gas being determined by the indications and contraindications in each lung. We have carried out bilateral collapse in 14 cases, 2 of which are clinically well and 12 are dead. The prognosis in cases so severe as to demand a bilateral pneumothorax is very grave, but the procedure will often add much comfort and prolongation of life to the patient.

Out of the 423 cases included in this study, 345 cases were collapsed. Of the 345 collapsed cases, 264 had demonstrable disease in the opposite lung, 82 cases having well-defined deep peribronchial infiltration, *but in 182 cases the disease amounted to fibrocaseous infiltrations or dis-*

seminated bronchogenic caseous extensions. In these 264 cases progression of disease in the contralateral lung took place in 24 cases as shown in table 7.

TABLE 7

Progression of disease in the contralateral lung in collapsed cases

STATUS OF CONTRALATERAL LUNG	NUMBER OF CASES	PROGRESSION NUMBER CASES	CHARACTER OF COLLAPSE
Deep peribronchial infiltrations	82	2	2 partial
Disseminated bronchogenic caseous extensions	36	3	1 satisfactory 2 partial
Active fibrocaseous infiltrations	109	17	7 satisfactory 10 partial
Quiescent fibrocaseous infiltrations	37	2	2 partial

INFLUENCE OF PARTIAL COLLAPSE ON CONTRALATERAL LUNG

Conclusions drawn from a statistical analysis of the behavior of the contralateral lung in the presence of a partial collapse of the worse diseased side are unreliable for the reason that the more the partial collapse partakes of the character of a satisfactory collapse, the more the end-results will approach those of a satisfactory one and, contrariwise, the more limited or localized the partial collapse, the more the end-results will approach those of the "No Free Space" cases. Furthermore, the end-results in pneumothorax therapy in cases under partial collapse are, for the most part, so little influenced by the behavior of the contralateral lung and so dependent upon the type of disease in the worse diseased lung and the character of collapse, that any deductions based upon the various types of contralateral lung disease would certainly lead to erroneous conclusions.

There can be no constant uniformity in end-results in cases under partial collapse, for the reason that there is no uniformity in the character of partial collapse. It would be misleading to compare the end-results of a case with an active fibrocaseous contralateral lung with a partial collapse which approached a satisfactory collapse, with a case with an essentially negative contralateral lung in which the pneumothorax was very limited or transitory in character.

Even with these facts in mind, reference to table 3 will reveal certain illogical discrepancies in the partial-pneumothorax group which might lead to erroneous conclusions unless one was familiar with the circumstances surrounding these cases.

For example, in the "Deep Peribronchial Infiltration" group under partial collapse, there were 33 cases, 60 per cent of which are dead, whereas of 21 "No Free Pleural Space" cases, with the same type of contralateral lung, only 43 per cent are dead, which would lend support to the opinion that in the "Deep Peribronchial" cases the partial pneumothorax was not only of no value but was actually detrimental. An examination of the individual case-records of this group shows that the partial collapse was of value, for 16 were temporarily improved and only 4 were progressively fatal, whereas all the "No Free Pleural Space" control cases were progressively fatal.

Furthermore, even though these 16 improved cases were ultimately fatal, they should not be altogether chargeable to partial-pneumothorax failures, since 3 cases died of intercurrent disease not related to tuberculosis. Three more patients in this group who voluntarily discontinued treatment, believing themselves cured, later suffered a relapse of their disease which proved fatal. Three additional cases, which were steadily improving under sanatorium regimen, left the sanatorium against advice and lived under very unfavorable social and economic conditions, which undoubtedly provoked a reactivation of disease.

As further evidence of the favorable influence of a partial pneumothorax in this group of cases, 32 out of 33 cases under partial compression had a tubercle-bacillus-positive smear before pneumothorax treatment and only 14 had a positive smear on discontinuation of pneumothorax treatment, whereas of the 20 "No Free Pleural Space" cases, 19 had a positive smear before sanatorium treatment and 14 had a positive smear upon discontinuation of treatment.

Out of 81 cases with an essentially negative contralateral lung, extension was noted in 4 instances, 3 of which were satisfactory collapses and the extension was of such a character that it required discontinuation of pneumothorax treatment.

Pleurisy with effusion in the contralateral lung occurred in 5 cases, four of which had an active fibrocaseous infiltration in the contralateral lung and one had a disseminated bronchogenic caseous extension into the contralateral lung.

CONCLUSIONS

1. A classification of the status of the contralateral lung is necessary if accurate deductions based upon end-results are to be made.

2. The end-results of pneumothorax therapy are less dependent upon the status of the contralateral lung than they are upon the character of collapse and type of disease in the worse diseased lung.

3. The various types of contralateral lung lesions vary greatly in their prognostic significance.

4. Fibrocaseous infiltrations involving the upper portion of the lung offer a more favorable prognosis than the bronchogenic extensions into the lower portions of the lung.

5. The mere presence of disease in the contralateral lung does not contraindicate collapse of the worse diseased side.

6. Râles in contralateral lung disease must be carefully studied in order to determine their pathological significance.

7. The absence of râles in a diseased contralateral lung by no means indicates absence of activity.

8. Cavity cases with abundant expectoration should be subjected to early pneumothorax treatment in order to prevent aspiration infection of the opposite lung.

9. Very active contralateral lung disease should be allowed to subside before instituting pneumothorax on the worse diseased side.

10. In the presence of contralateral lung disease great caution should prevail in collapse of the worse diseased lung.

11. In some cases, the worse diseased lung should be held merely separated from the chest wall pending observation of the behavior of the contralateral lung.

12. Flexibility or rigidity of the mediastinum plays an important rôle in the behavior of the contralateral lung during collapse.

13. Excellent results are occasionally attained by cautious collapse, even in the presence of extensive contralateral disease.

14. Satisfactory end-results are frequently proportionate to the degree of watchfulness accorded the contralateral lung.

15. The status of the contralateral lung should be observed by frequent physical and roentgenological examination, and accurate records should always be maintained.

16. Auscultatory phenomena transmitted from the worse diseased to the contralateral lung should be differentiated from those findings due to active disease in the contralateral lung.

17. The contralateral lung, when diseased, should always be suspected when unfavorable clinical symptoms arise.

18. In this series, in the presence of a satisfactory collapse of the worse diseased lung, end-results were much better with any type of contralateral lung lesion than those of the "No Free Pleural Space" cases, with an essentially negative contralateral lung.

19. Out of 345 collapsed cases, progression of disease in the contralateral lung, demanding discontinuance of pneumothorax treatment, took place in 24 cases.

20. Heretofore, possibly too much conservatism has been exercised in the selection of material presenting contralateral lung disease.