"ARTIFICIAL PNEUMOTHORAX IN THE TREATMENT OF

PULMONARY TUBERCULOSIS

WITH SPECIAL REFERENCE TO THE SELECTION OF

SUITABLE CASES."

THESIS FOR THE DEGREE OF M.D. (GLASGOW UNIVERSITY)

PRESENTED BY

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The modern treatment of Pulmonary Tuberculosis by Artificial Pneumothorax is the outcome of the observations by Clinicians and Pathologists, many years ago, that a case of Phthisis Pulmonalis might develop a spontaneous Pneumothorax, that the advent of such a complication might not prove immediately fatal, and that there did appear, at a later date, signs of healing in the affected lung.
These observations led to the acceptance of the general principles of "Compression Therapy", whilst its detailed application as a useful and comparatively safe therapeutic measure has resulted from careful experimentation and accurate observation over many years by, first of all, a few pioneers, and later by a multitude of workers in the world-wide anti-tuberculosis campaign.

My work amongst those suffering from this terrible scourge has given me an insight into the magnitude of the problem, not only from the medical, but also from the social and economic standpoints. It was with the firm conviction that no method should be left untried which might prove helpful to ameliorate the lot of the tuberculous, that I decided, early in 1913, to utilise the ready advice and kindly help of Dr. H. De C. Woodcock, of Leeds, and to adopt Artificial Pneumothorax as an adjunct in the treatment of patients at the Tuberculosis Sanatorium, Killingbeck, Leeds.

The work, thus commenced, has been carried on continuously since then by me, save for an interrupted period of three years, consequent upon the European War.

I have endeavoured, in the pages that follow, to summarise this method of treatment and, from the results obtained, to detail its applicability in suitable selected cases.

Historical Summary:

Nearly a century ago, James Carson of Liverpool first conceived the possibility of using Pneumothorax as a therapeutic measure. To a British observer, therefore, full credit must be paid for the pioneer work, (in this) as in many other branches of scientific research. The method thus suggested was quickly adopted and systematised by continental observers, amongst whom Potain (France), Forlanini (Italy), Murphy (America) and Brauer (Germany), were the pioneers.(1.) To Forlanini (1882) we owe much, in that he was an early and assiduous worker. Although he failed, for a time, to realise the importance of manometric observations as a safeguard against accidents, yet he must be commended for his unyielding opposition to Brauer's "Incision Method" for first injections.(2.) Forlanini's method of puncturing the chest wall with a hollow needle is now most generally adopted. Brauer's introduction of a manometer to enable the operator to determine variations in the intra-pleural pressures has done more than anything else to make Artificial Pneumothorax a safe, scientific and practicable measure. About 1880, Caley attempted to arrest severe haemoptysis by inducing pneumothorax. The crude and complicated apparatus and methods in use by the earlier observers, have given place to more accurate and comparatively simple appliances and technique, as the result of the extensive experience of such workers as Saugmann in Denmark,

and Parry Morgan, Vere Pearson, Lister and Woodcock, in this country.

Compression or Collapse Therapy is, therefore, a recent institution, for it was about 1906 that Artificial Pneumothorax became a recognised procedure of practical importance. Since that date the experiences of many observers have appeared in current literature. These records have warranted a close scrutiny, in that they have been most helpful to me in the practical application of this form of treatment, and I have appended in the bibliography of this paper as complete a list of these as was possible.

Seledtion of the patient:

The ideal case for treatment by Artificial Pneumothorax is undoubtedly one presenting signs of early, unilateral disease. The number of such cases presenting themselves for treatment is regrettably small. This state of affairs is, I feel sure, due to a considerable extent to the insidious nature of the onset so often met with in Phthisis Pulmonalis. The symptoms are often so masked as to give the patient the impression that all is well with him, and the signs are frequently so obscured as to mislead even the careful medical attendant. One must also bear in mind that most patients with Pulmonary Tuberculosis, especially those classified in stages 1, 1-11, and 11 of the Turban-Gerhardt scale respond well to sound sanatorium treatment alone, and one might hesitate to subject such a case to the risk of Pneumothorax-induction In weighing the evidence in such a case, the possibility of recrudescence of activity of the disease at a later date must not be lost sight of.
After a careful survey of the patient's condition as to type and magnitude of the lesion in the lung has been made, and after a close watch has been kept upon his progress for some weeks under sanatorium conditions, if I should feel inclined to the belief that it might be possible to hasten quiescence of the tuberculous process and lessen the risk of recrudescence at a later date, then I should not hesitate to recommend the addition of Artificial Pneumothorax to his treatment. So far, I have only dealt with the case in which there is the

possibility of inducing a more or less permanent quiescence of the disease, and I would again emphasise the fact that such cases are few in number.

Our experience in Leeds, however, has proved that in Artificial Pneumothorax we have a powerful weapon if used in the amelioration of troublesome symptoms; e.g., the control and arrest of haemoptysis, and a beneficient effect in relieving the septic phenomena so often met with as the result of secondary infections in Phthisis - e.g.,

1. Lessening the quantity of sputum - often foul-smelling and loaded with Staphylococci, Diplococci, Pneumococci, &c.
2. Lessening the degree of febrility.
3. Lessening the night-sweats.

Other uses to which the principles of Artificial Pneumothorax induction have been put by me include:

(a) The treatment of Bronchorrhoea.

(b) Assistance with aspiration of Pleural Effusions.

(c) Control of a troublesome case of spontaneous Pneumothorax with subcutaneous surgical Emphysema.

These cases are referred to in detail later.

Cases with marked bilateral disease are obviously unsuitable for treatment by Artificial Pneumothorax. Such cases, unfortunately, are by no means uncommon in hospitals and sanatoria, and it is difficult to ignore their plaintive desire for a trial of the treatment.

I have been tempted to accede to the requests of several cases of this type, and have induced unilateral or bilateral Pneumothorax.

The immediate results have in many cases been satisfactory, in that amelioration or abatement of troublesome symptoms has occurred, but it is questionable whether the ultimate result has warranted a continuation of the treatment.

Forlanini, Leonard Colebrook[3][5], &c., have performed with successful results Artificial Pneumothorax on both sides alternately, after a due interval, but Vere Pearson[4] points out the inadvisability of such a procedure, owing to:

1. The hopelessness of the outlook.
2. The almost certain presence of extensive adhesions in such cases.
3. The probability that life will be shortened by it.

A patient should not be selected as a suitable candidate for this treatment if he is of a highly neurotic temperament. Such patients are apt to be troublesome during the operation, and one such patient may, by his behaviour, render a whole ward hostile to the method. For this reason young children are, as a rule, unsatisfactory for this form of treatment, but, unfortunately, the adult type of Pulmonary Tuberculosis with rapidly advancing caseation is comparatively rare amongst children of tender years. There is almost always a certain amount of nervousness on the part of the patient during the first induction. This is seldom persistent or severe, and has practically disappeared from my practice since I have adopted the routine procedure of treating the first induction as a purely educational measure.

This has been effected by confining myself to the preliminary technique, the administration of the local anaesthetic and, in favourable cases, the estimation of the intra-pleural pressures, and by refraining from the introduction of gas during primary inductions. As the refills proceed, the patient usually evinces a more or less intelligent interest in the procedure and, later, comes to regard the operation with considerable tranquillity.
In fact, one girl after several inductions would occupy her time during the operation with a novel, while another became so disinterested as to fall fast asleep. Her statement that the gas - Nitrogen was used in her case - "always makes me feel heavy", was not corroborated by any other case, nor has reference to this peculiarity been noted elsewhere.
Patients showed marked disinclination at first to consent to the treatment, and this attitude of hostility was maintained until one day, when, by accident, I discovered the cause - viz., the erroneous impression had got about amongst them that in this treatment the heart was interfered with by "being pushed to one side." Their fears allayed, the presence in their midst of a handful of cases doing well under this treatment, soon gave the method popularity amongst them; so much so, that the operation has even been the subject of a very clever cartoon by one of the patients.

The Technique.

The tendency, within recent years, has been towards simplicity in the technique of the operation. The types of apparatus in common use very considerably as regards details of construction, but all have been designed with one object - to lessen, as far as possible, the risk of the advent of dangerous complications.(6to9.) The operation itself is not intricate, but the procedure requires time, and careful attention to a few simple details. The period of time varies according to the nature of the case, the presence or absence of pleural adhesions and the number of previous refills, but is generally about twenty minutes in an average case. The operator is well advised on no account to hasten the procedure, and to exercise great care in Asepsis and in close observation of the Manometer.

Choice of Method:

For a first induction the operator has the choice of two methods:

I. The Incision Method:(2).

II. The Puncture Method:(6).

Both these methods have their devotees. The chief exponents of the Incision Method have been Lucius Spengler, Brauer and Neumann, whilst the Puncture Method has found favour with Forlanini, Saugmann, and most of the observers in this country.

Neither method is without risk, but the advantages of a primary incision down to the Pleura seem to me to be outweighed by the risks of subsequent Haemorrhage, Surgical Emphysema and Sepsis. These risks are certainly not so apparent in the Puncture Method, which has been my routine practice.

The Puncture Method is used for refills.

Preliminary Technique:

For some hours before the operation, the patient is encouraged to get rid of as much sputum as possible, by alteration of his postural position, by advice and by the administration of expectorant mixtures. A simple enema should be given.(10). This will help to lessen abdominal tension, and so induce greater freedom of diaphragmatic movement.

For the first two or three inductions, especially in a patient who is at all nervous, I have been in the habit of administering Morph. Hydrochlor. gr. 1/6th hypodermically about one hour before the operation. The resultant narcosis will help to lessen or prevent the occurrence of the "Pleural Reflex" - which is a form of shock manifested by symptoms of collapse of the patient, a feeling of faintness and a sudden drop in the pulse rate, and is due to reflex stimulation through the Pneumogastric Nerve - fatal cases from this cause have been reported.(6).

The skin of the affected side of the chest is now prepared by scrubbing with Ether Soap, and washing with spirit; Tincture of Iodine is then applied by means of a sterile swab.

The position of the Patient:

This should be so arranged as to ensure a minimum of discomfort for the patient, and a maximum exposure of the site of operation, together with a widening of the intercostal spaces at that site. He should lie on the bed or couch on the unaffected side, with the shoulder of that side raised on a pillow, whilst another pillow is placed under the chest. The arm on the affected side should then be brought round in front of his body, with the hand at the level of his head, to ensure a moderate degree of comfort.

The Site of Election is the sixth interspace in the area between the mid-axillary line and the posterior axillary fold. In such a position, the subcutaneous tissues are thin as a rule, and it is possible to avoid superficial vessels and powerful muscles. On the left side it is advisable to keep as close as possible to the posterior axillary fold.

Other sites may have to be chosen in certain cases, but are not so satisfactory. When I have failed to induce Pneumothorax at the site of election above described, I have on several occasions satisfactorily utilised the area close to the angle of the scapula posteriorly.

The operator now, under aseptic conditions, proceeds to the administration of the local anaesthetic. This is performed in two stages, and the anaesthetic used is 2 ccs. of a 1 % solution of Novocain in sterile normal saline, with the addition of 5 minims of a 1 in 1,000 solution of Adrenalin (Parke Davis & Co.).

STAGE 1: One c.c. of the anaesthetic is injected subcutaneously.

STAGE II: One c.c. is then injected slowly into the deeper intercostal tissues.

It is of prime importance to note that the anaesthetic solution should be warmed before use, and the same care should be exercised with the Pneumothorax needle and the gas when these are introduced later.

I have observed in 30% of my cases of primary induction, the occurrence of a taste sensation when the deep injection of Novocain is made. The complaint of a sour taste in the mouth follows the act of injection with such rapidity as to suggest a reflex nervous origin, and to exclude absorption by the Lung. On three occasions, amongst my earlier cases, the patients complained of faintness and nausea at this stage - symptoms which I suspected might be due to sensitiveness to Novocain. This led me to adopt Quinine-Urea Hydrochloride as the local anaesthetic. One c.c. of a 0.5 % solution was employed, as manufactured by Allen & Hanbury's Ltd. The use of this anaesthetic was so frequently accompanied by pain at the site of injection, and by the occurrence of a persistent thickening of the subcutaneous tissues, that I was compelled to abandon it and to return to the employment of Novocain. It is interesting to note that symptoms of sensitiveness to Novocain have practically disappeared since I have insisted upon using a warm solution.

The Apparatus:

The apparatus used in all my cases was the portable box type suggested by Dr. Woodcock, and manufactured by Messrs. Reynolds and Branson of Leeds. It has the advantages of simplicity, cheapness and suitability for the administration of Nitrogen, Air or Oxygen.

The essential parts of the apparatus are:

1. A Water Manometer. This consists of a long cylindrical glass vessel, with the Zero mark half way up, and marked off in inches on either side of the Zero mark. It contains a narrow glass tube, open at its lower end, connected by rubber tubing at its upper end with the rest of the apparatus, and suspended in the cylinder so that its lower end is about half an inch from the bottom of the cylinder.

II. A means of receiving, containing, warming and injecting the Gas.

This is obtained by means of two glass bottles, one fixed and the other movable vertically, connected by a length of rubber tubing to form a syphon. The fixed bottle of 600 c.cs. capacity is of the Wolff's pattern, contains a thermometer, and is connected with the rest of the apparatus and with another smaller bottle containing ~~Acid~~ ALKALINE Pyrogallate of Soda. By the simple process of closing a stop-cock and reversing the syphon, air is made to bubble through the Pyrogallate solution, and the Nitrogen thus produced passes into the container. The movable bottle is connected with the fixed bottle by rubber tubing, which contains a stop-cock, so that the flow of water through the tubing can be regulated.

III. A Three-way cock: This is connected up by rubber tubing with:

(a). The patient.

(b). The manometer.

(c). The gas bottle (which stands in a metal casing containing warm water).

The reason for the interposition of the three-way cock is to permit of the Patient's being connected with the Manometer only, and, later, with the whole apparatus.

To avoid a laboured description of the details of the apparatus, I have pleasure in submitting for inclusion in this paper, an original pen and ink sketch by one of the patients who received this treatment. It is a very accurate sketch but, unfortunately, one important detail has been omitted - viz., the inclusion of a small glass chamber containing cotton wool in the rubber tubing which connects the patient with the Manometer. This glass chamber is inserted some three inches from the needle, and is used to detect the presence of Haemorrhage or free fluid.

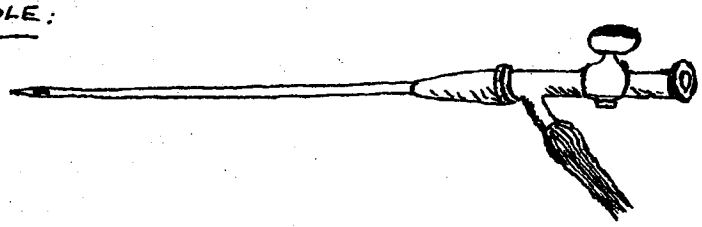
The needle used is that designed and used by Saugmann. It is a hollow needle, with an eye opening at the side, but as close to the point as possible.(12)to(14). At its basal end it contains two openings.

1. At the side by means of which it is connected to the Manometer, and

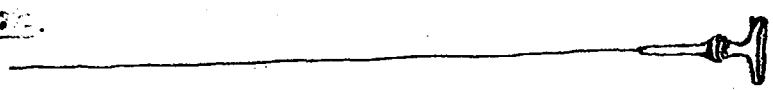
2. A vertical opening which permits of the passage of the ~~stilet~~ stylet into the needle, and which, on withdrawal of the ~~stilet~~ stylet, can be closed by means of a small tap.

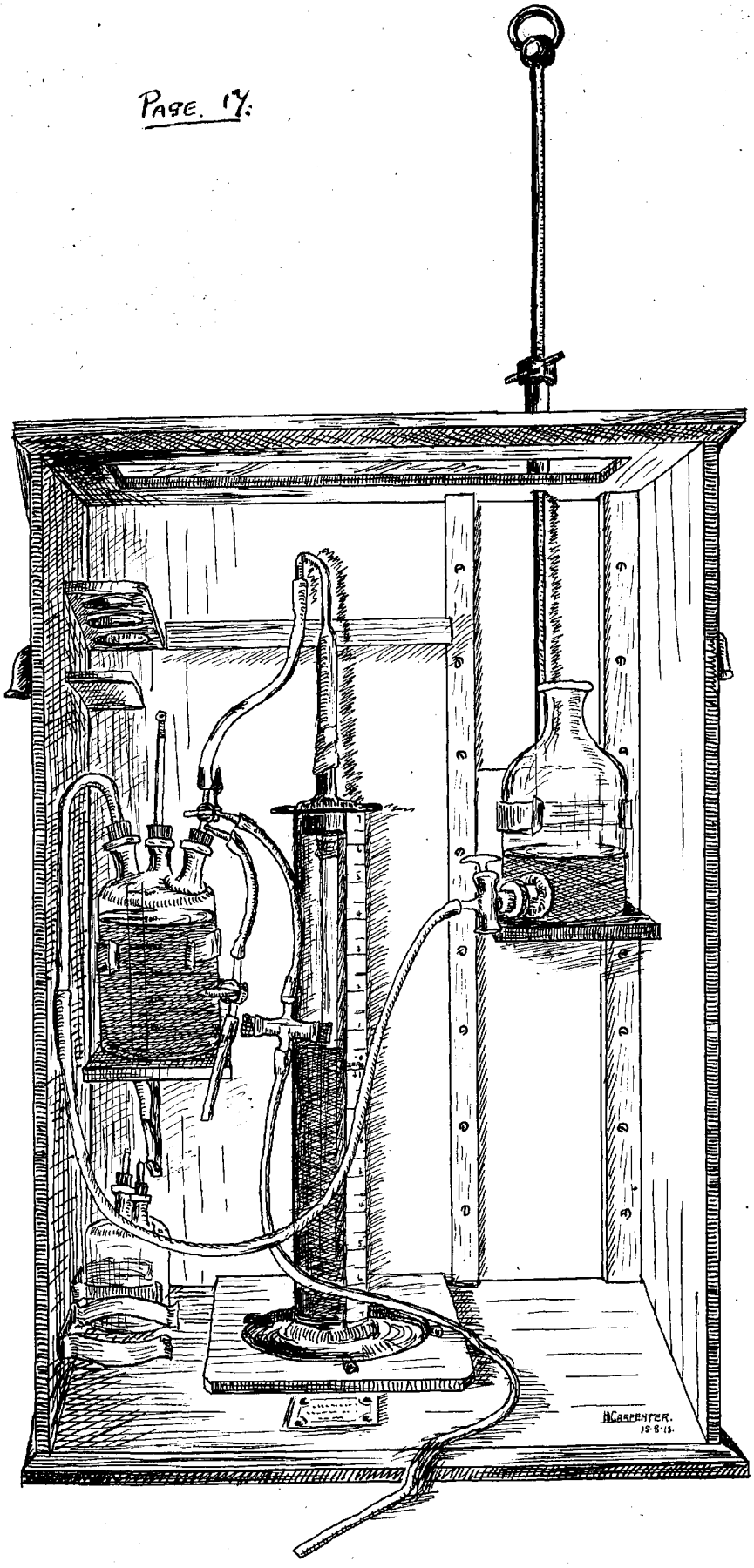
Here follows drawing of Apparatus.

NEEDLE:



STYLET:





Apparatus for the Induction of

Artificial Pneumo-Thorax.

The Choice of Gas:

The absorptive power of the Pleura is well known and has long been recognised. To realise the importance of this power, one has just to consider the numbers of cases of Pleural Effusion which never require to be tapped, or are tapped only once, and so on.(15).
In consideration of this fact, and of the rapidity of absorption of Oxygen by the body, Nitrogen became the gas of choice. However, a pleura which is punctured frequently, and which becomes thickened, rapidly loses its absorptive power. Experience has shewn that Oxygen is not absorbed by the frequently punctured Pleura as rapidly as we previously feared; at any rate, its absorption does not necessitate unnecessarily frequent refills. Oxygen has the additional advantage in that it is less likely to cause Gas Embolism, with serious OR ~~and~~ fatal results.
Nitrogen was administered in most of my earlier cases, but for the past twelve months I have confined myself to the use of Oxygen or Air.

It is advisable to allow a short interval of time to elapse to ensure efficient action of the local anaesthetic. This interval will be taken up with the preparation of the Gas and the regulation of the apparatus just described.

The needle, which has been sterilised by dry heat, to obviate the presence of moisture in it, is now connected with the Manometer only, and is inserted slowly into the selected intercostal space. The operator now carefully observes the Manometer. As soon as the intra-pleural space is reached, the water in the Manometer tube will rise rapidly, indicating a negative pressure in the intra-pleural space. The amount of the rise and of the respiratory oscillation will of course depend on the presence or absence of pleural adhesions in the vicinity of the puncture.

The Manometric readings are now carefully noted, and, if it be a primary induction, the needle is withdrawn; a pad of gauze with collodion is applied to the puncture and a strip of adhesive plaster is applied to the chest to help to prevent the occurrence of Surgical Emphysema.

If the operation be conducted for a refill, the procedure is similar and the needle is inserted as described above. Then the operator waits until the respiratory oscillation is free and sensitive to respiratory movements before he places the patient in connection with the rest of the apparatus by turning the three-way cock.

Provided respiratory oscillations remain unimpeded, Gas is made to enter the chest by means of the water syphon.

The amount of gas used varies in individual cases, but depends on:

(a). The general condition of the patient - e.g., the onset of cough, the state of the pulse, &c., and

(b). The rate of inflow. The Manometer is one's guide here, and the speed of the inflow of gas should be carefully regulated and <u>should be slow</u>.

I find it advisable to stop the flow entirely from time to time during the induction, and observe carefully any alterations in the Manometric readings.

If pain or discomfort ensue, the gas tap should immediately be closed.

The gas usually flows in while the Manometer registers a negative pressure, but, if adhesions are present, it may be necessary to resort to a pressure that is slightly positive. This must not be done with a primary induction or one of the earlier refills, for a Gas Embolism may arise. After all, our object is to encourage fibrosis - i.e., adhesions, and not to break them down.

So far I have described the technique as applied to a satisfactory case. However, I will now endeavour to describe briefly some of the difficulties and dangers that may be encountered.

Difficulties:

I have already referred to the difficulties encountered if the patient be of a neurotic temperament or be sensitive to Novocain, and have indicated the measures adopted to counteract them.

The act of puncturing the pleura is sometimes sufficient to set up a violent fit of coughing. This risk is minimised if care has been taken to get rid of as much sputum as possible before the operation, and if the local anaesthetic has been given deeply, and has been allowed sufficient time to act. A certain amount of Dyspnoea is sometimes complained of during the operation. This complaint is certainly much less frequently heard when Oxygen is the gas used. If coughing or Dysphoea should occur, it is wise to stop the flow of gas and wait a little. Should there be no sign of abatement of the troublesome symptom after a few seconds have elapsed, the needle should be withdrawn and the operation finished. Violent coughing is a fruitful source of subcutaneous emphysema.

Of the difficulties, there still remain to be described a few connected with the use of the apparatus.

When the needle has been inserted into the intercostal space, to a depth considered sufficient for its eyelet to have reached the intra-pleural space, there may be no manometric response. This may be due to closely adherent and thickened pleura at the point punctured, or it may be caused by a blocking of the needle. If no Haemorrhage or fluid from a pleural effusion be visible on the cotton wool in the glass chamber already described (17), I now carefully use the stylet.

The tap in the needle is opened and the stilette carefully inserted, and then withdrawn. It is then closely examined for moisture, blood, a small clot, or a small particle of fat; all of which I have encountered from time to time. Frequently this manoeuvre has the desired effect of inducing movement in the manometer. I have at times been able to locate the intra-pleural space by the simple process of turning the needle round slowly and moving its point ever so gently from side to side. A close watch must, of course, be kept on the manometer while this is being done. If the attempt to reach the intra-pleural space is still unsuccessful, one may try the method advocated by Woodcock, viz., of attaching a hypodermic syringe to the needle, and slowly withdrawing the piston. By this means, one may sometimes be able to determine the presence of blood in the needle.
If this should also fail, one must assume that the intra-pleural space, or, as Brauer and Spengler describe it "the potential space between the pleura costalis and the pleura pulmonalis," is obliterated at the site of the puncture, and one must try another site at the next operation.
Densely thickened fibrotic pleura would give rise to such a condition. I have seen Costal Pleura quite 1/8th" thick, and of a white glistening appearance in a case of Tuberculous Pleurisy examined post-mortem.

Dangers:

Puncture of the Lung: This is the chief danger, and is one which may happen with the most careful observer, but it should not become serious if due care be exercised. The golden rule for observance should be - "never put the patient into connection with the gas apparatus until you have observed a negative rise in the manometer reading, and a free and normal response of the Manometric oscillations to respiratory movements." Let me quote the following paragraphs from the admirable article on "Artificial Pneumothorax," by W. Parry Morgan, which appeared in the Lancet on the 11th July 1914.(18)&(19). He says: "The difficulties will be appreciated when we remember that the operator is required to carry down his needle to a point at which it will separate the parietal and visceral pleura which are in apposition at an unknown depth, and also to verify that it has reached its proper position between these, before gas is allowed to flow in. The dangers which have to be taken into account are the possibility of injuring the lung, and the risk of allowing gas to pass into places other than the pleural cavity." Parry Morgan then proceeds to describe his method of accurately estimating the intra-pleural pressure at the needle point, and of obviating contact of the needle-point with the lung.

1. Injury to the lung, resulting in a leakage of alveolar air into the intra-pleural space, and

2. Valvular action of the lung on the needle eyelet, resulting in interference with the manometric reading are thus prevented. He accomplishes this by introducing a manometer to register the pressure in the Nitrogen container only, and another manometer to register the

pressure in the intra-pleural space.
Injury to the lung is apt to give rise to the most serious of all the dangers connected with ~~this~~ Compression Therapy, viz., Gas Embolism.
Several fatal cases of accident due to Gas Embolism [20][21][22]. have been reported; the gas, injected into a vein in the injured lung, passes into the cerebral vessels, with fatal results. No case of this nature has occurred in my experience.

Post-operative Technique:

After a primary induction the patient should be kept absolutely at rest for several hours, and should be kept in bed for twenty-four hours, to ensure quiescence. The patient should not be permitted to partake of a heavy meal during this period. One of my patients was given her dinner, by mistake, about half an hour after her second refill, and rapidly became somewhat collapsed. She suffered from some Dyspnoea and Cyanosis, followed by vomiting, which passed off without further mishap. Since then my practice has been to permit a cup of weak tea with a slice of thin buttered toast about an hour after the operation, and to refrain from allowing the patient to partake of a solid meal for at least six hours. With later refills, patients present greater tolerance to the treatment.

Those patients who have left the Sanatorium, and who attend for treatment periodically, report in the Ward at 9.0 a.m. and are put to bed. The operation is performed two or three hours later, and by 4.0 p.m. the patient is usually able to get up and proceed home. Should any interference with the pulse or respirations manifest itself, the patient is kept at the Sanatorium overnight.

Progress of the Treatment:

It is impossible to lay down definite rules as to the intervals of time that should elapse between refills, for each case must be treated on its own merits. Until a Pneumothorax has been established, the intervals should be of short duration. Later, the frequency of refills will depend on the rapidity of absorption of the gas.

One is guided to an estimate of this rate of absorption by a comparison of the manometric readings at successive inductions, and by the rapidity of the inflow of the gas during an induction.

The routine which has been found most satisfactory, and is now adopted at this sanatorium, is on the following lines. Forty-eight hours after the primary (educational) induction has been carried out, the operation is repeated and again three days later. Thereafter, if circumstances are favourable, an interval of a week is allowed to occur. This interval between the inductions is maintained for six to eight weeks, and is then gradually extended to ten days, fourteen days, one month, and then three months.

Continuation of the Treatment:

The period during which the treatment should be continued varies considerably in individual cases. Most authorities are agreed that compression therapy should be maintained for about eighteen months with, of course, the proviso that it may be necessary to recommence the treatment at a later date, should signs of activity of the tuberculous process reappear in the lung.

Aids to Treatment:

1. General Hygiene:

All my cases, treated by Artificial Pneumothorax were, during the earlier part of the treatment, living under sanatorium conditions - viz., fresh air, periods of rest and of carefully regulated exercise, and an abundant and nutritious dietary. I found that the frequent visits to the sanatorium for refills by patients who had returned to their own homes served a useful purpose, in that they helped to remind them of the need for enforcing similar conditions at home.

2:
Blood pressure estimations: It was assumed that compression of a lung would give rise to an alteration in the blood-pressure elsewhere. To determine the nature and extent of this alteration, the blood pressure was taken immediately before, and shortly after, the operation in a series of cases. The results were so variable and the deductions in consequence, so unreliable, that I discarded this procedure altogether; e.g., a few cases, taken at randon from the series, shewed the following:-

One case after two consecutive inductions shewed a fall of 15 mms. and of 10 mms. of Hg. in the blood pressure. Another, under similar conditions showed a rise of 40 mms., a fall of 20 mms. and a rise of 25 mms. of Hg. after three consecutive inductions. Error due to the personal factor was reduced to a minimum, as the estimations quoted were taken by the same individual, under precisely similar conditions on each occasion.

3. Use of the X-Rays:

I have been unable to use Radiography as a routine measure, owing to the fact that an X-Ray apparatus has not been installed at the Sanatorium. However, practically all cases, on their return home, have been screened from time to time at the Central Tuberculosis Dispensary, Leeds. Unfortunately, until recently, one had to confine one's attention to radioscopic examination, owing to the unsuitability of the apparatus for accurate radiographic work. With the desire to obtain information as to the progress of the treatment, especially with regard to the question of fibrotic changes in the compressed lung, I availed myself as frequently as possible of the opportunity to attend during the radioscopic investigations. The evidence thus accumulated was, however, far from conclusive, for the following reasons.

1. The cases thus screened were cases in which a more or less complete, long-standing, Pneumothorax had been induced.
2. There were no radiographs to permit of comparison between present and past X-Ray findings.
3. The lung shadows (23) - caused not so much by the deposition of Fibrin as by the absence of air - varied considerably in any individual case.

Even the radiating lines from the roots of the lungs, towards the periphery - due to the presence of the larger Bronchi and blood vessels - varied in depth and extent.

Parry Morgan (19). utilised Radiography to prove that after a first induction the X-Ray photograph shews evidence of more gas in the pleural cavity than has been introduced from the induction - apparatus, and concluded that the air must have entered from the lung itself.

It is regretted that, for the reasons above given, further investigation was impossible.

For much valuable help, and for making the arrangements for radioscopic observations, &c., I am indebted to Miss A.L. Powell, the Secretary of our Dispensary.

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vide APPENDIX — Plates I & II.

Summary of Cases:

1. Cases of Spontaneous Pneumothorax: These were five in number, and involved one Male and four Females. Their ages were 15, 21, 26, 29 and 37 years. In two, the right side of the chest was affected, and in three, the left side. All the cases shewed signs of advanced bilateral disease with cavitation, and all ended fatally. One case lived only 15 minutes after the onset of the Pneumothorax; one case died 20 hours after; two cases 48 hours after; and one case lived for twelve weeks after the occurrence of this complication. None of these cases had been treated by Artificial Pneumothorax.(27). Post-mortem examinations were made in two of these five cases, and, as they throw a certain amount of light upon the problems discussed in this paper, I propose to describe these two cases in greater detail.
It is of interest to note that a severe Haemoptysis - 1 pint of blood in all - occurred four days prior to the onset of spontaneous Pneumothorax in one of the cases which survived for 48 hours.(28).

Case 1: Annie B. 21 years, Motor Driver, was admitted to the Sanatorium upon 27th January 1919 suffering from advanced bilateral Pulmonary Tuberculosis. She was very ill, was rapidly losing weight, was a febrile case, and was confined to bed.

Upon 27th April 1919 she had a severe attack of coughing about 11 p.m. At 11.45 p.m. on the same evening, she gave a sharp cry, and sank back on her pillows. I saw her at 12 midnight and found life extinct.

The right side of the chest bulged considerably, and its percussion resonance was markedly tympanitic.
It was presumed that the severe bout of coughing had occasioned this sudden spontaneous pneumothorax which ended fatally in such dramatic fashion.
The cough was not of exceptional severity until just before the catastrophe. There was an entire absence of signs of abdominal complications, and there was no history of diarrhoea or alternating diarrhoea and constipation.

Post-mortem: 26th April 1919:

The body was well nourished. External appearances were normal except for a slight bulging of the right side of the chest throughout its entire extent, with undue prominence of the intercostal spaces on that side.
On my opening the chest wall, gas escaped from the right side under pressure, and with a hissing sound.
The Heart was displaced considerably towards the left side. The cardiac muscle was pale, but the heart was normal otherwise. It weighed 6 ozs.
The Lungs: The right weighed 23 ozs., and the left 17 ozs.
On the right side, both layers of the Pleura were thickened and connected by numerous bands of strong adhesions, especially at the Apex.
The Lung was collapsed except for its upper lobe, which was firmly adherent to the chest wall. I discovered two small openings, each of the size of a pins head in the visceral pleura, one on the external aspect of the middle lobe, and the other close to the diaphragmatic aspect of the lower lobe. The opening in the middle lobe led to a small cavity in the lung, while the lower opening communicated directly with a bronchiole, which

was filled with muco-purulent exudation. The lung parenchyma was studded with tuberculous deposits, some shewing cheesy caseous masses, and others, of larger size, shewing extensive caseation with cavitation.
The left lung was bound to the chest wall by exceedingly strong fibrous adhesions, and shewed extensive tuberculous disease with apical cavitation.

Abdomen: The liver, spleen and kidneys were congested, but healthy. The intestines shewed extensive tuberculous ulceration with lymphatic involvement and enlargement of the mesenteric glands. The ileo-coecal region was chiefly affected.

Cause of Death: Tuberculosis of Lungs and Abdomen, and Spontaneous Right Pneumothorax.

Case II:

Winifred H. 15 years, mill hand, was admitted upon May 26th 1919, suffering from extensive bilateral pulmonary tuberculosis, with cavitation. She was very ill, with intermittent febrile temperature, and was confined to bed. There was no history of intermittent diarrhoea prior to admission. Emaciation was marked, and eventually became extreme.

At 8.0 a.m. upon 10th June 1919, a soft swelling over the upper part of the left side of the chest and over the left shoulder was noticed by the Ward Sister. At 10 a.m. on the same day I saw the patient and found that this painless swelling now involved the whole of the trunk and both legs, and was rapidly spreading to the face and both arms. The condition proved to be extensive subcutaneous Emphysema.

By utilising the Artificial Pneumothorax apparatus, I found that the intra-pleural pressure on the left side was + 9 inches. I then reversed the apparatus, thus withdrawing air from the intra-pleural ~~pressure on the left side~~ space and the manometric reading rapidly became negative. This procedure was continued for twenty minutes, but it was noticed that the intra pleural pressure immediately increased when the withdrawal of air was stopped. A cannula was now inserted into the subcutaneous tissue near the angle of the left scapula and the Pneumothorax apparatus withdrawn.

The patient's condition remained, as stated, until her death at 8.0 p.m. upon the 11th June 1919.

P-M Examination:

General: Great emaciation with extensive subcutaneous emphysema was present.

Chest:)
Heart:) Appeared normal and weighed 6 ozs.

Lungs: The Right Lung shewed extensive disease of the whole of this Lung - viz., numerous tubercular deposits with marked congestion of the intervening lung substance. There was extensive cavitation of the upper lobe. The Lung weighed 28¼ ozs.

Left Lung: There were strong fibrous adhesions which firmly bound down this lung to the chest wall. Upon separating these adhesions I discovered a circular patch of ulceration about the size of the brim of a teacup, and involving the Lung substance and both layers of Pleura. This patch of ulceration occupied a position near the angled of the ribs, and exposed portions of the 4th, 5th and 6th Ribs. This ulceration appeared to be a recent extension from a cavity in the lung close by.
There was no sign of Haemorrhage. The Left Lung weighed 24¼ ozs.

The Abdomen: Shewed extensive ulceration of the large and small Intestines, with involvement and softening of the Mesenteric Glands.

Cause of Death: Phthisis Pulmonalis, Spontaneous Pneumothorax and Surgival Emphysema.

Case I - Illustrates the conditions usually met with in fatal spontaneous Pneumothorax, and several similar cases have been recorded in the literature.

Case II - Presents a most unusual picture, and I am not aware of any reference to a similar occurrence in the cases reported elsewhere. It is important to note the extensive fibrotic changes found in the Lungs in both these cases, for one must take into account the tendency of certain forms of the tuberculous process to produce Fibrosis in arriving at a conception as to the amount of Fibrosis for which treatment by artificial Pneumothorax is responsible.

II: Cases treated by Artificial Pneumothorax:

The total number of patients treated by this method during the period under review was 130. This involved 939 operations, or an average of 7.2 inductions per case. The youngest patient treated was eleven years of age, and the oldest fifty-two years.

Classification of the Cases according to their age-periods at the beginning of the treatment:

Up to 15 yrs:	16-20:	21-30:	31-40:	41-50:	over 50:
1	21	64	27	6	1

87 of the cases were Males and 43 were Females.

The operations were performed on the Right Side in 74 Cases.
" " " " Left Side " 51 "
" " " " Both Sides " 5 "

2,200 ccs. of Oxygen to control Haemoptysis - was the Maximum amount for one induction.

No. of Cases.	Gas used and average amount per induction per Case:
83	Nitrogen ..... 580 ccs.
43	Oxygen ..... 570 ccs.
4	Air ..... 100 ccs.

Summary of the Results of Treatment:

1. The absence of the writer on Active Service.
2. The conversion of the Sanatorium into a temporary Military Hospital, and
3. The removal of ex-patients from the city elsewhere, in consequence of Munition Work, Active Service, or the house-shortage, have all contributed to make the task of following up the results of treatment a very difficult one.

However, the following summary is as accurate as was possible under the circumstances.

Artificial Pneumothorax was successfully induced in 81 cases; of these, 16 died within the period under review.

In the remaining 49 cases, the attempt was only partially successful, or failed entirely, and of these cases 11 died.

The period during which treatment was maintained varied in the non-fatal cases, from 4 months to 3 years.

Non-fatal Cases with successful induction of Pneumothorax thus number 65 in all. After the treatment, 51 of these shewed improvement, while 14 were not improved.

Improved:

Stage I.		Stage II.		Stage III.	
M.	F.	M.	F.	M.	F.
7	6	19	9	9	1

Not improved:

Stage I.		Stage II.		Stage III.	
M.	F.	M.	F.	M.	F.
0	0	4	0	7	2

Non-fatal with induction partially or not successful were 38 in all.

After the treatment, 7 of these were improved, while 31 were not improved.

Improved:

Stage I.		Stage II.		Stage III.	
M.	F.	M.	F.	M.	F.
0	0	5	2	0	0

Not improved:

Stage I.		Stage II.		Stage III.	
M.	F.	M.	F.	M.	F.
0	0	4	5	13	9

Fatal Cases: i.e., Cases in which Artificial Pneumothorax had been attempted and in which death took place during the period reviewed:-

These cases numbered 27.

No. of Case: and side treated:		Interval between the 1st induction and death:	Cause of death:
1.	L.	5 yrs.	Influenza and Broncho Pneumonia.
2.	R.	2 mths.	Asthenia.
3.	R.	3 mths.	Haemoptysis.
4.	R.	3 mths.	Abdominal Tuberculosis & Asthenia.
5.	R.	6 yrs.	Influenza and cardiac valvular disease.
6.	L.	11 mths.	Haemoptysis.
7.	R.	6 mths.	Abdominal Tuberculosis & Laryngitis.
8.	L.	3 mths.	Abdominal Tuberculosis & Laryngitis.
9.	R.	4 yrs.	Influenza.
10.	L.	4¼ yrs.	Asthenia & Laryngitis.
11.	L.	8 mths.	Asthenia & Laryngitis.
12	Both.	4 mths.	Asthenia & Laryngitis.
13.	R.	12 mths.	Cardiac disease & Asthenia.
14.	L.	4 mths.	Abdominal Tuberculosis.
15.	Both.	6 mths.	Asthenia.
16.	R.	14 mths.	Abdominal Tuberculosis.
17.	L.	5 mths.	Asthenia.
18.	R.	3 yrs.	Asthenia (following Influenza).
19.	L.	12 mths.	Abdominal Tuberculosis.
20.	Both.	9 mths.	Asthenia.
21.	L.	1 yr.	Influenza & Broncho Pneumonia.
22.	L.	2 yrs.	Asthenia & Laryngitis.
23.	Both.	4 mths.	Asthenia.
24.	L.	2⅔ yrs.	Asthenia.
25.	R.	1 mth.	Asthenia.
26.	R.	5 yrs.	Generalised Tuberculosis.
27.	R.	1 yr.	Influenza & Pneumonia.

It will be noted that of the five bilateral cases one still survives. She still suffers from periodical attacks of Dyspnoea, but is otherwise in fairly good health. In her case the bilateral operation was undertaken for Haemoptysis. It will also be noticed from the foregoing table of fatal cases that the Influenza epidemics of 1918-19 exacted a heavy toll.

Failure to induce a Pneumothorax in the 36 cases mentioned above was due to a variety of conditions, chief among which was the absence of manometric oscillation, owing to the presence of pleural adhesions. This accounted for 16 failures, while severe pain was present in 9 cases, and 6 advanced and hopeless cases were treated for symptomatic reasons. The continued appearance of blood in the needle accounted for 2 more cases of this class; the presence of Cardiac Valvular Disease in 4 cases proved to be a contra-indication to this treatment, because during the inductions the pulse became markedly intermittent. In 1 case the relatives of the patient refused to permit me to continue the treatment, although the patient himself was willing, was an early case and would probably have done well. In 22 of these cases there was a history of Pleurisy prior to admission. A history of Pleurisy does not necessarily mean the presence of Pleuritic adhesions. Only the attempt to induce Artificial Pneumothorax will decide.

III. Cases in which Artificial Pneumothorax was used as a symptomatic measure.

1. For Haemoptysis: 17 cases were thus treated with beneficial results either immediate or remote in 14. I have selected a case for a more detailed description of the method as employed in dealing with these cases, of Haemoptysis.

Two cases died from Haemoptysis, and I have failed to trace one case.

(II) For Febrility, Night Sweats, &c: From the experience in the treatment of this series of cases I am convinced that Artificial Pneumothorax has a beneficial effect in lessening troublesome symptoms. The quantity of the sputum shews a tendency to diminish, and T.B. to disappear. In a successful case as the refills proceed; The temperature range soon alters in such cases from febrile to sub-febrile or normal registers; and the night-sweats diminish in severity and frequency.(24).

(III). The Special Cases detailed in subsequent pages illustrate I: One case out of a total of 5 in which aspiration of fluid from the chest was materially assisted by the introduction of gas.(29).

II. One case out of 2 such cases of Bronchorrhoea treated with(temporarily) satisfactory results by this method.

Opinion has been divided in the past as to whether Laryngitis when present, serves as a contra-indication to this form of treatment. In my series of cases no less than 14 of the patients who improved considerably under treatment had Laryngitis as a complication. It stands to reason that if the quantity of sputum is lessened, the Laryngitis will itself improve, and this happened in the cases referred to, as in the cases quoted by Zink.(30). However, I cannot recollect any case in which the hoarseness entirely disappeared, as happened in a case quoted by C. Lillingston - who, by the way, received Artificial Pneumothorax himself with excellent results.(26) In the case mentioned by Lillingston, there was complete return of the patient's natural voice after one year's treatment.

Post-Mortem Results:

Of the 27 Fatal Cases in this series, only 9 were examined post-mortem, owing to the fact that most of the patients died in their own homes. I have made it a routine procedure to test the intra-pleural pressures of all cases examined in the post-mortem room, but, so far, the cases have been so few, ~~the~~ and the results so variable, that the expression of an opinion on the results is not yet possible. All cases examined after treatment, especially those in which a Pneumothorax was of several years duration, shewed extensive Fibrosis, not only by the presence of adhesions and thickened Pleura, but also by the presence of fibrous tissue in the Lung parenchyma. It is, of course, impossible to say how much of this Fibbosis was evoked by the method of treatment adopted. That healing had taken place to a considerable extent, was manifested in two cases in which symptoms and signs of Active Lung Disease had been absent for a considerable period, and in which the patients had succumbed to an intercurrent malady.

The following case illustrates the P.M. appearances met with after treatment by Artificial Pneumothorax.

Thos. Blanchard F. Was admitted upon 27th May 1918, with a history of cough, expectoration, Haemoptysis, Loss of Weight, and Night Sweats of 18 months duration.

He was found to be suffering from advanced Pulmonary Tuberculosis of Right Apex and Middle Lobe; and his sputum was found on examination to contain Tubercle Bacilli in large numbers, and shewing clumping.

Right Artificial Pneumothorax was commenced, and he had 15 inductions prior to May 21st 1919, when this treatment was discontinued owing to the appearance of abdominal complications. He died from Abdominal Tuberculosis upon 4th September 1919.

P.M. Examination:

The body was extremely emaciated.

The intra-pleural pressures were: Right - 2": Left ± 0.

Chest: Right Lung was contracted. The Pleural layers were separated by air, and by 3 ounces of pale straw coloured fluid. No Tubercle Bacilli were found in this fluid on subsequent examination.

The lung texture shewed advanced Fibrosis. At the Apex and Root the lung tissue shewed marked cicatrixation, and dense fibrous tissue formation, and strong bands of adhesions bound the Lung to the chest wall at the Apex posteriorly.

Glands at the root of the Lung shewed enlargement and infiltration, with Tuberculous material.

Left Lung: In this Lung I found a few old healed Tuberculous lesions at the extreme Apex. The rest of the Lung was free from signs of disease except for a marked infiltration of the root glands. These were large and contained caseous matter.

The Heart was normal.

Abdomen: A large quentity of pale straw coloured fluid was present in the peritoneal cavity. There was multiple ulceration of the small intestine, with congestion of the surrounding bowel, lymphatic infiltration and enlargement of the mesenteric glands.

Cause of Death: Pulmonary and Abdominal Tuberculosis.

ILLUSTRATIVE CASES: I.

Case to illustrate general principles of Treatment:

1. Mary B. - age 26 years, a Machinist, was admitted to the Sanatorium upon April 9th 1914, suffering from General Malaise, slight cough in the early morning, and occasional night sweats. The symptoms had been observed since a severe attack of "cold" six months previously.

She had formerly been very susceptible to colds. There was no sputum. Koch's Subcutaneous Tuberculin Test and Woodcock's Blister Reaction had been carried out prior to admission, and gave positive results. Physical signs on admission, limited to the Right Apex, were:

Inspiration harsh and accompanied by fine crepitations: Expiration harsh and markedly prolonged. These were detected both anteriorly and posteriorly. It was decided to adopt Artificial Pneumothorax, and the following procedure was adopted:

13:IV:1914: 1st induction: site of selection:
Negative Pressure 3": Oscillation good.
200 ccs. Nitrogen used: Pulse 84 throughout.

15:IV:1914: 300 ccs. Nitrogen.

21:IV:1914; 450 ccs. Nitrogen.

28:IV:1914: 800 ccs. Nitrogen. Physical signs of a Partial Rt. Pneumothorax were now present.

6:V:1914: 1,000 ccs. Nitrogen.

19:V:1914: 1200 ccs. Nitrogen.

Patient was discharged upon 20th May 1914, with instructions to attend as an out-patient for further treatment.

2:VI:1914: 1200 ccs. Nitrogen.

16:VI:1914: 600 ccs. Nitrogen.

6:VII:1914: 600 ccs. Nitrogen.

26:IX:1914: 1000 ccs. Nitrogen - patient now working on "Khaki" - half day.

29:X:1914: 1200 ccs. Nitrogen.

7:I:1915: 1200 ccs. Nitrogen.

10:VI:1915: 300 ccs. Nitrogen - oscillation was not satisfactory.

17:VI:1915: 600 ccs. Nitrogen - Easily.

15:7:1915: 300 ccs. Nitrogen - oscillations poor.

29:VII:1915: 600 ccs. Nitrogen.

27:VIII:1915: 700 ccs. Nitrogen. - patient now on full work.

30:IX:1915: 600 ccs. Nitrogen.

5:LX:1915: 600 ccs. Nitrogen.

13:I:1916: 500 ccs. Nitrogen.

Treatment was now suspended and patient continued to keep well

30:III:1920: Patient is still alive, is still doing a full days work, and has been very free from colds.

ILLUSTRATIVE CASES; II.

Case to illustrate Manometric Observations, &c.

William Henry E.:- 34 years. Ex-soldier.

Admitted: 18th September 1919. Stage II: Right upper lobe affected: sputum positive.

Duration of illness: 2½ years.

Complications on admission: Laryngitis: (no ulceration visible on Laryngoscopic Examination).

Fistula in ant. (very slight discharge).

Discharged: For Farm Colony work: 16th March 1920.

Condition on Discharge: Lung disease quiescent.

Laryngitis improved considerably.

Fistula in ant. healed.

Treatment: Right Artificial Pneymothorax:

Date of induction

Date of Induction:	Amount of Gas:	Initial Pressure:	Gas at:	Final Pressure:	Sputum in ounces. (24 hrs)
25:IX:19 (1st)	Nil (Educational)				3
26:IX:1919	200 ccs. Oxygen	-3" (oscillation 1")	-1"	-2"	2
30:IX:1919	400 ccs. "	-2" (oscillation 1")	+.5"	+1"	3
7:X:1919	600 ccs. "	-3" (oscillation 1")	0 to -1"	-1"	4
14:X:1919	600 ccs. "	-2" (oscillation 1")	0 to -1"	" 0	4
24:X:1919	1000 ccs. "	-4" (oscillation 1.5")	-1"	0 to -1"	3
4:XI:1919	900 ccs. "	-3" (oscillation 1")	+0.5"	+1"	2
2:XII:1919	300 ccs. "	-2.5" (oscillation 1")	0 Some Dyspnoea.	-2"	3
25:I:1920	550 ccs. "	-6" (oscillation 1.5")	0	-1"	4
10:2:1920	800 ccs. "	-3.5" (os. 1")	+1"	0 to +1"	3
13:3:1920	600 ccs. "	-2" (os. 1")	0	0	1

ILLUSTRATIVE CASES: III.

Case to illustrate difficulties due to plural adhesions:

Thos. Hy. J. - age 22 years - Clerk:

Admitted - August 4th 1914:

History: A severe attack of Pleurisy (dry) on the Left side 18 months ago.

Since then he has had occasional attacks of pain in the Left side and has (had) a hard cough for 18 months with very slight expectoration. No other symptom had manifested itself.

On admission: Stage I-II: Left apex and axilla:

Respiratory murmur harsh and accompanied by persistent inspiratory and expiratory crepitations. Percussion resonance was impaired over the whole of the Left Lung. At Left Base, the respiratory murmur was faint: Sputum positive.

Treatment: Left Artificial Pneumothorax:

6:VIII:1914 200 ccs. Nitrogen (1st induction).

10:VIII:1914 No gas (no oscillation).

14:VIII:1914 200 ccs. Nitrogen.

17:VIII:1914 50 ccs. Nitrogen (sputum stained after the operation).

24:VIII:1914: No gas. (Manometer at Zero and no oscillation A second puncture was made at the angle of Scapula posteriorly and as oscillation was fairly good, 300 ccs. Oxygen were given.

4:IX:1914: 100 ccs. Nitrogen (punc. posteriorly - oscillation fair).

25:IX:1914: 300 ccs. Nitrogen (punct. Posteriorly - oscillation good).

1:X:1914: 150 ccs. Nitrogen (punct. posteriorly - oscillation varied).

I decided to stop the treatment as it was obviously impossible to induce anything like a complete Pneumothorax.

Patient had improved considerably under Sanatorium conditions, having put on 1 stone 3 lbs. in weight.

No moist sounds were audible in his Lungs when examined by me upon 14th January, 1915.

He left the Sanatorium, against advice, upon 16th Jan. 1915. He turned up a month later in the uniform of his old Territorial Battalion, and with the rank of Sergeant.

I understand he was killed on the Somme in 1916.

SPECIAL CASES - I.

Case to illustrate the treatment of Haemoptysis:

Mary Ellen S. age 25 years, Traveller, was admitted upon August 25th 1919 suffering from active caseation of the apex and root of the right lung, of five months duration. Her chief symptoms were cough and expectoration.

Her sputum had been frequently stained with blood, and on two occasions she had had about a tea-cupfull of Haemorrhage. Her sputum was found to contain "Tubercule Bacilli" when examined on admission.

Staining of the sputum persisted after admission, and the pulmonary signs indicated continued activity of the disease.

It was decided to try Artificial Pneumothorax.

Upon 5th September, she had 4 ozs. of Haemoptysis, and I decided to commence the treatment at once.

Right Artificial Pneumothorax was induced.

Oxygen was the gas used throughout.

Date.	Amount of Oxygen used.	Initial Pressure.	Gas at.	Final Pressure.	Daily sputum in Ounces.
5:IX:19	300 ccs.	-3"	-1½"	-2"	(Haemorrhage) 4
7:IX:19	425 ccs.	-2.5"	-1"	-2"	1 (Clear).
11:IX:19	600 ccs.	-2.5"	-.5"	-2"	1 (Clear).
18:IX:19	600 ccs.	-2"	-.5"	-1.5"	1 (Clear).
25:IX:19	600 ccs.	-2"	-.5"	-1"	1 (Clear). Up ½ day.
2:X:19	600 ccs.	-4"	-.5"	-1.5"	2 (Up all day).
9:X:19	750 ccs.	-1.5"	0 to -.5"	-.5"	2.
16:X:19	900 ccs.	-2"	-.5" to 4.5" -	-.5"	2.
26:X:19	1000 ccs.	-2"	0 to + 1"	-.5"	2.

Upon 3:XI:1919 she had an attack of severe Haemoptysis - 12 ounces measured.

She was put to bed and Morph. Hydrochlor. gr. ¼ was given hypodermically - followed by 2 ccs. of Haemostatic Serum

half an hour later. As the Haemorrhage persisted, recourse was had to Artificial Pneumothorax.

3:XI:19 1100 ccs. -3" +1" 0 to +.5"

6:XI:19 A further attack of bleeding - 12 ounces in all, and controlled by the administration of Morphia Hydrochlor. gr. ¼ hypod.

9:XI:19. Haemoptysis - 15 ounces - suddenly reappeared.

	1500 ccs. Oxygen.	-2.5"	+1" to +2"	± " +2"	4 (Haem.)
16:XI:19	1200 ccs. Oxy.	-3"	+1"	+1" to 1.5"	1 do.
30:XI:19	1200 ccs. Oxy.	-2.5"	+2.5"	+2"	1 do.
7:XII:19	1200 ccs. Oxy.	-3"	+1.5"	+1.5"	½ (Clear)
15:XII:19	1200 ccs. Oxy.	-2"	+3.5"	+3"	Nil
22:XII:19	1200 ccs. Oxy.	-2"	+3.5"	+2.5"	Nil
29:XII:19	1200 ccs. Oxy.	-2.5"	+2 to 2.5"	+2"	(up 2 hrs) Nil

The treatment has continued to have the desired effect, and at the time of writing the patient has had no further Haemorrhage (since 30th November) and a period of 5 months has elapsed. She has had 9 more inductions of 1200 ccs. at intervals of 10 days, and it is hoped she will be able to leave the Sanatorium in April to return monthly for refills.

Special Cases: II.

Case to illustrate the treatment of Pleural Effusion.

James P. age 44 years, Cartman, was admitted to Killingbeck Sanatorium upon 22nd March 1920. He stated that he had suffered from Anaemia, general wasting, and loss of voice, for about four months. His own doctor had explored the left side of his chest, and, on three occasions, the 14th, 17th and 20th inst, had withdrawn clear fluid from this side of the chest - about a pint on each occasion. After each aspiration the patient had been collapsed, and, on admission here, he was so ill, that I decided to postpone any attempt at aspiration. Upon 24th inst, severe Dyspnoea and Dysphagia manifested themselves. His face was cyanosed and the veins in the neck stood out prominently. His voice had now sunk to the merest whisper. These signs pointed to severe and increasing intra-thoracic pressure, which had to be relieved. Accordingly, I explored the left side of his chest, and found, a pale straw coloured and blood-stained pleural exudate. This fluid was subsequently examined, but no Tubercule Bacilli were found in it.

An aspirating syringe was now applied, and some of the fluid was withdrawn. When about half a pint had thus been removed, the needle of the Pneumothorax Apparatus was inserted in the intercostal space next but one, and higher up than the space occupied by the aspirating needle. Five hundred ccs. of Oxygen were now allowed to enter the intra-pleural space at a pressure of +6 inches, as indicated by the manometer.

page 50:

The outflow of fluid was appreciably increased by the induction of Oxygen, and the patient's condition was well maintained throughout. He remained fairly comfortable until his death from exhaustion nine days later. At the post-mortem examination, as was suspected from the symptoms, character of the fluid, etc., I found an extensive Mediastinal Cancer involving both Lungs, but especially the Left. The intra-pleural pressures, taken in the post-mortem room were: Right -1", and Left +2".

I have purposely chosen this case to shew that the introduction of Oxygen into the pleural space may help to prevent collapse during aspiration of fluid from the chest, even when the case is "in extremis."

Special Cases III.

Case to illustrate the treatment of Bronchorrhoea and Bronchiectasis:

Bronchorrhoea is of course a bilateral affection and, as it follows in the wake of Chronic Bronchitis, it is attended by marked cyanosis and Dyspnoea.
For these reasons it would appear that such cases are not suitable for treatment by compression therapy. However, it may be possible, by this means, to lessen the amount of the sputum, which is very copious, and as a rule foul-smelling.
With this idea in view, the following case was subjected to the treatment. The results were satisfactory, in that the patient was able to return to work, so much improved as regards the quality and quantity of his expectoration as to enable him to mingle freely with his work-mates without fear of rebuke.

James M. age 21 years, had been a patient at Deanhead Sanatorium some years prior to his admission here upon 21st January 1914. He was suffering from Bronchiectasis. Two or three times each day he was seized with violent fits of coughing, during which he expectorated a profuse quantity of foul-smelling sputum. In the intervals between these heavy bouts of coughing, his sputum was practically nil.
As the physical signs were more apparent on the Right side, it was decided to try Right Artificial Pneumothorax.

Date.	Amount of Gas.	Sputum in ccs.
13:2:14	200 ccs. Nitrogen	200 ccs.
17:2:14	200 ccs. Nitrogen	100 ccs.
24:2:14	600 ccs. Nitrogen	100 ccs.
3:3:14	600 ccs. Nitrogen	50 ccs.
10:3:14	750 ccs. Nitrogen	60 ccs.
17:3:14	1000 ccs. Nitrogen	40 ccs.
24:3:14	1200 ccs. Nitrogen	80 ccs.
7:4:14	1200 ccs. Nitrogen	40 ccs.

He continued to attend monthly for a refill after his discharge from the Sanatorium, and continued in fairly good health until August 8th 1914, when he was re-admitted to the Sanatorium, suffering from an attack of Bronchitis. This soon cleared up and the patient was still at work in April 1916, when I last heard from him.

CONCLUSIONS.

The treatment of Pulmonary Tuberculosis by Artificial Pneumothorax is not a new "cure" for all forms of this disease. However, it plays an important rôle as an adjunct to Sanatorium measures in the treatment of suitable selected cases.(25).
The cases which have responded most readily to this method have been the early cases with the lesion confined, or almost entirely confined, to one Lung, and such cases are all too rarely met with in ordinary Sanatorium and Hospital practice.
Certain cases, e.g., those with pleural adhesions, although considered suitable at first, may, after a trial of the treatment, be found to be unsuitable.
Rénon(33). points out that "the uncertainty which must attend the Diagnosis of the exact condition of the affected Lung and Pleura renders the choice of suitable cases extremely limited."
Keller has estimated that 7 per cent of Phthisis cases are suitable, and in 3.9 per cent the operation succeeds.
Leuret(31) and Lapeyre(32). say it is applicable to only 3 per cent of the cases. A trial of the treatment to alleviate the symptomatic manifestations or, perhaps, to hasten and prolong quiescence of the disease, is worthy of consideration where the lesions are more advanced. In very advanced cases troublesome symptoms may be controlled, and a moderate degree of comfort obtained for the sufferer.
The amount of fibrosis in the affected Lung is probably increased to a considerable extent by this method.
The successful cases are those in which the pleura becomes thickened and the Lung tissue tends to become fibrotic.

It is for the future to see:

(1) - Recognition of the utility of Artificial Pneumothorax in the treatment of Pulmonary Tuberculosis, and

(2) - Extension of the scope of its usefulness by its application to the early case.

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APPENDIX.

Both X-Ray plates are from the same case, and were taken a few days after a refill.

Plate 1: Illustrates the shadows radiating from the roots towards the periphery of the Lungs. Note the considerable increase in the density of the shadow on the right side towards the Apex.

Plate 11: Taken two days earlier, illustrates the commencement of an Artificial Pneumothorax. Note the edge of the Lung, which is commencing to recoil from the Chest Wall and the Diaphragm.

I am indebted to Dr. Woodcock for permission to copy these radiographs (by Dr. Rowden, of Leeds,) for inclusion in this paper.

PLATE I.

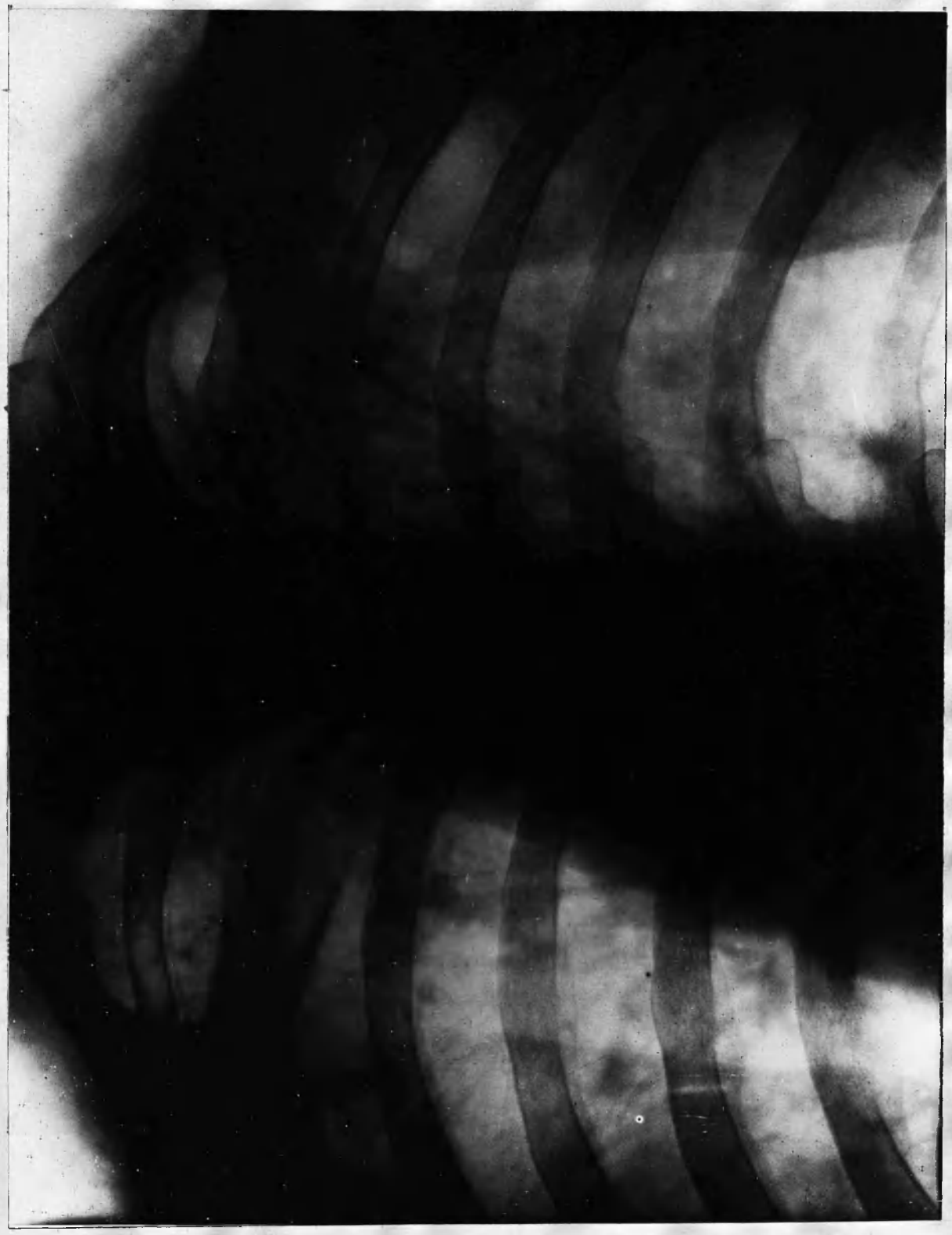

PLATE II.