causes of his particular brand of asthma, how to control attacks which he is unable to prevent, and above all how to be happy, in spite of the bad luck of having been born with the asthma diathesis."

THE ART OF ARTIFICIAL PNEUMOTHORAX

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It is the fashion in medical writing to give at the end of a paper, a list of references of those people to whom the writer is indebted. I propose to reverse the procedure and start by thanking my friends in the tuberculosis world, not entirely for their written work but also for their help, advice, and the numerous hours of discussion which have enabled me gradually to crystallise my thoughts on this subject.

Artificial pneumothorax is no new notion. It is on record that an ingenious physician attempted to introduce air into the pleural cavity as long ago as 1822. Unfortunately he met only with a *succes d'estime*. The father of "A.P." treatment was one Forlanini whose efforts were successful in 1888. Through his work and subsequently that of many others, the treatment of pulmonary tuberculosis by artificial pneumothorax, particularly during the past thirty years, has become increasingly the first line of offence.

Most people are under the impression that artificial pneumothorax treatment blows the lung down. This is quite wrong. It should be remembered that there is always a negative pressure (about -5 -15 cms. of water) in the pleural cavity. If this were not so, the lungs would not follow the contour of the chest wall during normal respiration. The introduction of air into the pleural cavity reduces this negative pressure and, in the absence of pleural adhesions, the lungs relax and so occupy a much smaller volume. They are also not subjected to the full stretching involved in normal respiration. By a dispensation of providence the diseased lung loses its elasticity and so becomes more collapsed than the sound lung. This results in the "selective collapse" in which sound lung remains expanded and partly functional while diseased lung becomes increasingly collapsed.

The principal value of artificial pneumothorax therapy is the closure of tuberculous cavities. But there are other advantages which must not be forgotten. The treatment may extend over years and the frequent refills accompanied by

regular screening of the chest ensure adequate supervision of the patient. Thus any extension of the disease or deterioration of the patient's general condition is noticed at the earliest possible moment. Furthermore, there is the by no means negligible psychological value to the patient who feels that something is being done for him. This I regard as most important, and in my opinion frequently justifies the maintenance of a mechanically imperfect pneumothorax, which from the consideration of radiological appearances alone should be abandoned. This is a controversial point, but I maintain that if the pneumothorax is carefully kept up with small refills and without raising the intrapleural pressures even to zero, the dismal prognostications of the surgeons—viz. infected effusions and broncho-pleural fistulae, etc., do not often occur.

Pneumothorax may have to be assisted by ancillary measures:

I. Phrenic evulsion or "crush," causing paralysis of the diaphragm either permanently or temporarily, and allowing further relaxation of the lung and some relief from the concertina movement involved in normal respiration.

II. Division of pleural adhesions (Intrapleural Pneumolysis). This is performed with an operating thoracoscope, using either a diathermy or cautery.

III. Pneumoperitoneum — particularly with phrenic paralysis on the more affected side, to increase the diaphragmatic elevation. Thus it will be seen that there are many permutations and combinations of treatment which come under the broad heading of Artificial Pneumothorax.

The treatment of tuberculosis by pneumothorax is, rightly, the only form of collapse therapy which has been left to the tuberculosis physicians by the thoracic surgeons. It is a simple procedure to induce a pneumothorax and simpler still to do a refill, but it is essential that it should be a painless operation. The induction is done with a fairly wide bore needle (Heaf's induction needle is my own choice) with a local anaesthetic.

After the collapse has become well established refills should be done with a needle of finer bore (Morland's needle is easily the best) without an anaesthetic. The needle must be introduced quickly and deliberately for the operation to be painless. It is, however, necessary to be certain that the needle will go through the intercostal space and not hit the rib—which is definitely painful and impairs one's reputation!

It is unwise to squirt the local anaesthetic into the pleural cavity unnecessarily and the needles should be dry sterilised and not used wet with spirit. The pleura appears to be a delicate and temperamental membrane, especially in the early stages of an artificial pneumothorax, and I have

definitely formed the opinion that pleural effusions, which may gravely affect the course of the treatment, occur more frequently when the pleura is regularly anointed with stray drops of foreign fluids.

When discussing the indications for collapse therapy the candidates for an artificial pneumothorax can be divided into approximately three classes based on their prognosis.

(I) Those who might recover permanently without active interference but who one thinks would be less likely to relapse if their disease were mechanically controlled.

(II) Those cases with more extensive disease, and usually with a persistently positive sputum who are destined to become the "chronics" subject to periodical relapses. This group has an expectation of life of five years or less, if the disease is not mechanically controlled.

(III) Those who will inevitably die in a few months if some attempt is not made to control the disease.

If as a result of one's treatment one can honestly say that a Class (III) case has become a Class (II)—or that a Class (II) case should have a reasonable chance of remaining fit if the artificial pneumothorax is maintained (i.e. the Class (II) has become virtually a Class (I) case), the treatment has been very successful.

It is no use blinding oneself to the fact that pulmonary tuberculosis is a disease with a high mortality. The following two approximate figures are fairly representative of this country:

(1) Fifty per cent of primary notifications of pulmonary tuberculosis are dead within a year of notification.

(2) Eighty per cent of new cases with a persistently positive sputum are dead within five years.

With these figures in mind the rather depressing statistics from large-scale surveys of artificial pneumothorax treatment do not do the treatment justice. There is little doubt that the artificial pneumothorax case, even if the duration of his life has not been greatly increased, is during his treatment, better in general health, capacity for work without relapse, and more free from the risk of infecting others, than a similar case relying on conservative treatment only.

The indications for artificial pneumothorax treatment are remarkably wide. It should be tried always in:

I. Cases with unilateral disease with positive sputum.

II. Cases with unilateral disease without positive sputum, but with radiological evidence of cavity formation.

Even when one's clinical sense says that pleural adhesions will probably prevent a satisfactory

collapse, it is doubtful if it is justifiable to advise a thoracoplasty without having attempted an artificial pneumothorax. Sometimes the artificial pneumothorax works, and the patient has been saved a mutilating operation. Bilateral disease is no contra-indication, always providing there is enough sound lung tissue to sustain the life of the patient. It is usual to attempt to collapse the more affected side first and to be guided by the results as to when the less affected side should be attacked.

The main contra-indication for collapse therapy is obviously when the disease is so gross in extent that the patient would be unable to breathe if any more lung tissue were put out of action mechanically. However, one does not embark lightly on artificial pneumothorax in patients over the age of 50, or in those with a pronounced bronchitic tendency. Tuberculous disease elsewhere is no contra-indication, and laryngeal tuberculosis in particular often improves considerably when the lung lesion is adequately controlled.

The justification for the title of this paper "The Art of . . ." lies in the management of a pneumothorax. It is easy enough to learn to introduce a needle into the pleural cavity, but it needs much experience to know when to induce and how much air to introduce. Every case is an individual problem and it is impossible to lay down hard and fast rules.

At the outset, it must be stated that, practically without exception no artificial pneumothorax should be started unless the patient is in a sanatorium or hospital, and that X-ray facilities must be easily accessible from the beginning. Physical signs alone, besides being merely not helpful, are frequently misleading. I have often heard quite normal breath sounds all over a well-collapsed lung.

The most important part of the induction is to know when to do it. It is very tempting to attempt to produce a dramatic improvement by collapsing the offending lung in the acute stage and in the presence of a hectic temperature, but I am quite sure this is a grave mistake. Too often a rapid spread appears in the contra-lateral lung, or a tuberculous pyothorax develops. At least three weeks bed rest should be tried in order to see if the fever tends to subside; if after three weeks the chart shows no downward trend it is justifiable to attempt an artificial pneumothorax induction though one knows the prognosis is that much graver. The disadvantage of waiting for the temperature to subside, is that pleural adhesions may develop—in my opinion this risk is a much lesser evil.

Refills need to be done frequently after the induction of a pneumothorax, but within a fortnight or so, weekly refills can usually be allowed. A

complete collapse is seldom achieved in the first few weeks, nor is it desirable. The degree of collapse should be increased very carefully and gradually. I am sure that unduly large refills in the early stages of an artificial pneumothorax cause breaking rather than gradual stretching of pleural adhesions with resulting avoidable pleural effusions.

The aim should always be to achieve the desired collapse with the least possible increase of the intra-pleural pressure. This may mean frequent small refills but it is well worth the small extra trouble, if only for the increased comfort of the patient. After an artificial pneumothorax is well established, the patient should not be short of breath after a refill unless a refractory cavity will not stay closed with the usual negative pleural pressures.

The care of a bilateral pneumothorax is an art in itself. A balance has to be struck between controlling the disease and leaving enough lung tissue functioning for the patient to be comfortable. This, of course, means frequent small refills. Both sides should be refilled on the same day when both artificial pneumothoraces require a fill at the same time interval. This avoids having a tendency to mediastinal displacement one way one week and the other way the next. A bilateral pneumothorax may cause some worry if an effusion develops on one side. If the effusion continues to reform after one or two experimental aspirations, I usually allow the lung slowly to re-expand beneath the effusion by stopping the refills on that side.

If during the course of a unilateral pneumothorax, a spread of disease occurs, it is usually on the contra-lateral side. Unless the spread is very extensive, there is no reason to withhold a pneumothorax on the newly affected side and it is tempting providence to delay the induction until the first side has re-expanded—a practice which still has some devotees. The newly affected side should be collapsed as soon as the patient's general condition permits and a bilateral pneumothorax continued for a long time. A note on the termination of this treatment will be found later in this paper.

The complications of pneumothorax treatment deserves some mention. In the past "pleural shock" has been discussed. I doubt the existence of the condition. An air embolus, I think, accounts for all the symptoms. These can be anything from a slight faintness to paralysis, collapse and death. It is a most frightening condition for the operator, but if due care is taken that the needle is in the pleural space before air is introduced, it is fortunately a rare occurrence, and if the patient does not die, recovery is complete. A spontaneous pneumothorax occasionally superimposes itself on an already collapsed lung. The diagnosis

may be difficult if one is not fairly experienced in the chest diseases, but the patient often gives a clue by saying "it feels like a very tight refill." An X-ray is necessary for confirmation. Once diagnosed the treatment is obvious, i.e. the removal of air through a needle inserted into the pleural cavity in the usual way. This may have to be repeated, or the needle can be tied in the chest and connected with a water bottle below the bed if relief is not obtained by a single decompression.

Surgical emphysema occasionally occurs—more frequently after the induction than after a refill, but except for some discomfort and considerable surprise when the patient feels it, it does not call for alarm or any particular treatment.

Pleural adhesions presumably come under the heading of complications, as they interfere with the satisfactory collapse of the lung. Mention has already been made of the operation "intra-pleural pneumolysis" and the technique has so improved that there is no reason why an adhesion, which is actively prejudicing the patient's recovery, should be left alone. I would like to point out that this should be done before the patient is discharged from sanatorium. The decision should not be left to the unfortunate Tuberculosis Officer, who has to disappoint the patient by sending him away for a second spell of institutional treatment within a short time of his returning home in his own mind as a "cure."

The most important complication is, of course, the formation of fluid in the pleural cavity. The nature of the fluid varies from the so-called simple effusion to thick tuberculous pus, but in my own mind I regard them as different degrees of the same condition. I strongly advocate conservative treatment in these cases. The fluid often absorbs without interference. It is my practice not to aspirate unless the effusion is so large as to be causing the patient discomfort or constitutional symptoms. I have seen too many cases with persistent sinuses to be enamoured of frequent aspirations, pleural washouts, and the like. If the effusion becomes purulent and contains many tubercle bacilli, I even stop the refills and wait for the lung to re-expand beneath the fluid, which in many months, often forms a mantle at the apex controlling the area of the lung which was originally diseased. Surgical procedures, i.e. thoracoplasty, are being advocated at an earlier and earlier stage of tuberculous pyopneumothoraces, even in the absence of grave constitutional disturbance. A pyothorax is likened to a time-bomb in the chest—many supposed time-bombs in the war proved to be "duds"! Furthermore, a collection of tuberculous pus is not regarded as an indication for immediate operation in surgical tuberculosis,

and I fail to see why the same surgical principles should not be applied to pulmonary tuberculosis.

The results I have obtained from conservative methods of treatment of the tuberculous effusions, have certainly been much better than the figures recently published to show the necessity for early operation. If, however, as a result of aspirations and washouts the pleural cavity has become secondarily infected surgical measures are nearly always necessary, but the prognosis in these cases is not at all good.

In the care of pneumothorax cases, the most difficult decision to make is when to terminate the treatment, particularly in view of the fact that once a lung has been allowed to re-expand the two layers of pleura usually become adherent and it is not then possible to re-induce the pneumothorax if one finds that healing is not complete. My own practice is never to tell a patient that an artificial pneumothorax is required for any definite period, but it is obvious that a small area of disease requires a shorter period of rest than a large one. It has been my experience that the lightly infected lungs re-expand fairly quickly (2 years or so) and no efforts on the part of the physician will keep the

lung down. More gravely damaged lungs remain complacently collapsed for periods up to ten years, if an obliterative pleurisy has not occurred in the meantime. Those cases which obliterate by themselves usually seem to do well. However, if no obliteration has taken place, I take the view that it is little trouble to the patient or his attendant to have a dozen refills a year—the patient has a feeling of confidence and close supervision is maintained. As a general rule, I suggest that the greater the extent of pulmonary damage, the longer should the affected area be controlled by artificial pneumothorax. This applies particularly to cases of bilateral pneumothorax.

In conclusion, I would like to point out that though generalisations are necessary in a paper of this length, every artificial pneumothorax case should be regarded as an individual and fascinating problem. Furthermore, it must be emphasised again and again that routine fluoroscopic examination at the time of the refill and serial radiograms at frequent intervals are not only desirable adjuncts but imperative necessities in the adequate management of artificial pneumothorax therapy.

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