medical attendant was urgently sent for. On rising in the morning she had been again seized with pain in the left side of the chest, so violent that she became partly unconscious, and was found pale and exhausted, with a pulse of 50, very weak and compressible and intermittent every tenth beat. After a few days' rest she had improved, but rising—against instructions—on the seventh day she had had a second attack in her bath, from which she very slowly recovered, being unable to rise without return of faintness, the pulse continuing of the same character. When I saw her I found the heart enlarged, with a definite impulse but irregular rhythm, an imperfectly developed systolic murmur replacing the first sound at intervals, a radial pulse scarcely perceptible, quite irregular, and not thickened.

Now this patient, with a personal history so relatively favourable, had lost her mother from fatty degeneration of the heart at 68, a maternal uncle and aunt both from heart disease about the same age, and a brother from heart disease at 30, and a sister was suffering from some form of cardiac affection at the time of her illness. She herself died eight years later. And I may remind you that amongst the hearts that are strained after 50 are hearts which have been already strained in some degree in youth and partially disabled. A country parson who had had to give up athletics at Oxford after running two hard races in close succession confessed to me that at 50 he fell off his bicycle in a faint.

Thus our two groups of cardiac strains, juvenile and senile, may be associated. Naturally there might be admitted into this group, if it were enlarged indefinitely, cases of physical strain in middle or advanced life of hearts that had been previously damaged in any respect or by any means whatsoever—by rheumatism, for instance, or by syphilis, as in several instances which I have already described to you.

In one sense cardiac failure may be said always to be the result of cardiac or cardio-vascular strain, relative if not absolute. The pressure within the chambers of the heart, the load that has to be moved, has been relatively too great for the driving power of the walls. But my present series consists only of cases in which acute strain came as a surprise, there being no knowledge (or at least no practical recognition) of previous damage of the heart, although in some instances it was believed to be "weak," or was occasionally disturbed. And further, in these cases the symptoms of strain, once developed, continued to recur indefinitely on muscular exertion.

The particular form of physical stress that falls upon the insufficiently resistant heart of a man in middle or later life is very various. The exertion of mountain-climbing, of keeping pace with younger men shooting in line, of bicycling with boys who set the pace, of hurrying to catch a train or the post (or to fetch an instrument, which I have known to strain a doctor's heart)—these and others are familiar incidents. One of the gravest cases of strain in middle age that I have ever met with was that of a distinguished sculptor, who ruptured his aortic valves in saving a heavy bit of precious statuary from falling. I have already referred to the effect on the gouty heart of unwise exertion at the week-ends.

In strain of the senile heart the symptoms subsequent to the acute pain or faintness of the actual event itself, when regarded comprehensively, resemble in one respect those which we have just studied in the after-history of juvenile strain. As far as they are characteristic, they are manifestations of the loss in different degrees of that reserve which the elastic and muscular walls of the heart possess for meeting extraordinary calls upon their properties and functions. In these subjects physical exertion of even moderate degree, different in different instances, is attended with a sense of discomfort, oppression or pain in the chest, and it may be down the arms, with consciousness of palpitating, irregular action of the heart. Each patient comes to learn the amount of the handicap of his heart and to moderate his work or exercise accordingly. Efforts after meals are particularly likely to provoke attacks. Rest affords relief. Naturally, in the relatively few instances in which the valves have been damaged or the orifices permanently dilated, the symptoms are more severe, and of the characters and associations familiar in the different forms of chronic valvular disease.

The physical signs of strain of the senile heart always include those of cardiac enlargement, and the impulse almost invariably is weak. Most commonly I have found the cardiac

sounds small or feeble, but the second often has a finely ringing quality. In 25 per cent. of my cases there was an apical systolic murmur; in 15 per cent. an aortic systolic murmur; in two cases a diastolic aortic murmur. The radial was sclerosed in rather less than half the cases, the tension low in more than three-fourths.

I have incidentally referred to the *clinical course* of strain of the senile heart. The limitations of its capacity for other than moderate physical effort naturally increase with age, and with the accumulation of other causes that tax the nutrition and strength of the heart. In my series the average age at which symptoms made their appearance was 56; the average duration of life thereafter in patients still living has been seven years, and in some considerably more. In fatal cases it was six years; but one patient died two months after climbing the steps of Milan Cathedral; another with ruptured aortic valves survived only eight months; a third, with a similar lesion, two and a half years. Of 20 patients belonging to this series seen during the past 13 years one-half are known to have died, some of them from cardiac failure, some suddenly with angina. Of the living those of no occupation have sent me a relatively favourable report of themselves; others who have been tempted to continue in business or to indulge in sport have returned with fresh complaints of distress.

In physical strain of the senile heart and vessels both of the two great orders of influences that may damage the cardio-vascular system are again found at work. But here, as I said, the order of invasion is reversed. The cardiac and vascular walls are first poisoned or impoverished and then over-stretched. We have seen that many of these subjects had already presented definite evidences of impairment of cardiac or arterial nutrition before the event which damaged them permanently. But Professor Dixon has demonstrated to us experimentally that violent dumb-bell exercise in men (presumably sound men) of 60 raises the blood-pressure to twice the height that it does in men of 23, or even higher. This observation of his proves not only how foolish it is for men over 60 to attempt, as some do, to keep pace with their juniors in severe physical exercise, but that their handicap, as I have called it, is heavier than most of them would condescend to acknowledge.

THE TREATMENT OF PHTHISIS AND HÆMOPTYSIS BY ARTIFICIAL PNEUMOTHORAX.¹

BY CLAUDE LILLINGSTON, M.B., B.C. CANTAB.

LITTLE notice has hitherto been taken in England of the treatment of phthisis by artificial pneumothorax which was advocated by Forlanini as early as 1882, and which has, undoubtedly, already saved the lives of many in the last stages of phthisis. In my own case the treatment was adopted only when sanatorium and other forms of treatment had failed to arrest the disease, and the prognosis was as unfavourable as could be. The success which ensued I have since seen repeated again and again in other patients. Samson in 1910 estimated that the number of published cases exceeded 400. Writers, such as Saugman and others, have only published those cases in which the treatment has lasted a considerable time. It is therefore probable that the number of patients who have undergone this treatment already far exceeds the above figure.

The quantity of foreign literature on the subject is already great. It is all the more striking to find so few original articles on the subject in the English medical press. The lack of interest in the treatment has had this ludicrous effect, that English pneumothorax patients at Davos were unable in the summer of 1910 to return to England owing to their inability to find anyone in this country with sufficient knowledge of the treatment to continue the injections of nitrogen.

It is, perhaps, one of the most striking features of the treatment by induction of an artificial pneumothorax that it has hitherto been almost exclusively applied in advanced cases of phthisis, and that in spite of this selection of the unfittest such good results have been obtained. In this respect the treatment compares favourably with other remedies, the efficacy of which seldom

¹ Extract from Thesis for degree of M.D.

extends further than to the first or second stage of the disease.

It is an old clinical experience that immobilisation of a tuberculous lung by pleurisy with effusion can be very beneficial. Adams, West, Sömme, and Paul Brock-Martens, among many others, have emphasised this point, and L. Spengler has collected 33 cases of hydropneumothorax, of which 10 recovered, the pulmonary disease being arrested in 6. It has also been found that aspiration of a tuberculous pleural effusion is often directly harmful. Hence the conclusion that the immobilisation of the lung, if it is to be of value, must be prolonged.

Immobilisation of the lung has been attempted by a variety of means ranging from the timid strapping of one side of the chest to the drastic resection of nearly half the bony thoracic wall. No doubt these extensive plastic operations have a future before them with the present rapid advance in thoracic surgery, but their application should at present be limited to those cases in which extensive pleural adhesions exist, preventing the collapse of the lung by more conservative methods.

A method of inducing collapse of the lung which has been advocated by Murphy in America and Brauer in Europe may be briefly described, as it is still practised, and its adherents claim for it certain advantages over Forlanini's method. Under local anaesthesia an incision is made into the skin over the selected intercostal space. The muscles are separated and the parietal layer of the pleura is exposed. A blunt cannula is now passed through this layer, and when, by passing a probe through the cannula, its point is found to rest between the two layers of the pleura, it is connected with a manometer and a cylinder containing nitrogen, of which several hundred cubic centimetres are admitted. It is claimed for this open method that the risk of fatal air embolism and of wounding the lung is avoided. Strict asepsis is, however, with difficulty maintained, and a fatal case of pyopneumothorax has already been reported by Brauer and Spengler as a sequel to this procedure.

After the first operation Brauer adopts Forlanini's method

modifications, and doubtless there is still room for improvement. A simple form of the apparatus is shown in the illustration.

I have tried a considerable variety of needles both on myself and on others, and have found that though the use of very fine needles is relatively painless, they have too narrow a bore to transmit the pressure within the chest to the manometer quickly enough. A thin-walled needle with large bore may be used, but such a needle buckles suddenly, as I found once to my cost. There are two needles in common use, each of which has its special advantages. Saugman's, which is of the thickness of a darning needle, has the lumen carried out to the point. The stilette can therefore be used to probe the tissues at the needle's point. The other end of the needle is connected with indiarubber tubing by a side stem. The main stem through which the stilette passes is supplied with a tap, and its opening is made to fit the nozzle of a syringe. Kjer-Petersen's differs from Saugman's needle only in this, that its point is solid, the slit-like opening being situated at one side of the needle close to its point. This needle is less liable to be clogged by connective tissue, and this is an advantage which any one who has experienced the difficulties of a first injection will fully appreciate. With this needle, however, the lung must inevitably be wounded before nitrogen can be injected, and the stilette cannot be used as a probe. Other useful forms of pneumothorax needle have been devised by Dr. S. Vere Pearson and Dr. L. Colebrook.

There is no *situs electus* for the puncture, but the point most commonly chosen is in one of the axillary lines in the seventh or eighth intercostal spaces. The operator is guided in his choice of site by the condition of the lung, his aim being to find a spot where the lung is healthiest, and to avoid the neighbourhood of cavities. As no general anaesthetic is given, a hypodermic injection of morphine is advisable half an hour before the operation. A local anaesthetic such as eucaine is also advisable.

The usual antiseptic precautions having been observed, the needle, connected with the water manometer, but cut off from the nitrogen by a clamp, is vertically thrust to the depth at which the pleura is to be found. By keeping a light hand on the needle the operator experiences a momentary sensation of resistance as the needle meets and then punctures the parietal layer of the pleura. If the point of the needle is within the blades of the unadherent pleura, and its lumen is not obstructed by connective tissue, the manometer will show negative respiratory oscillations, a typical reading being -14 cm. water on inspiration and -6 cm. on expiration. Variations of only 2 to 3 cm. on the manometer between inspiration and expiration may occur, and yet the point of the needle may be outside the pleura. When the oscillations show the mean pressure to be atmospheric, the readings being slightly negative on inspiration and slightly positive on expiration, the point of the needle is probably in the lung. If no characteristic oscillation occurs, the stilette of the needle should be used to clear it of blood or other connective tissue, care, however, being taken to close the needle quickly after cleaning, lest air be drawn in appreciable quantities into a vein.

Saugman when in doubt as to the position of the needle's point fits a syringe to the needle and aspirates. The presence of the needle's point in a vein can thus readily be discovered. On several occasions Saugman has aspirated blood, thus showing the wisdom of this precaution. Holmboe has called attention to the fact that the puncture of a vein is associated with more than the usual amount of pain, and this is a valuable warning. It is essential that the needle be carefully dried before use, as the presence of water in it is sufficient to prevent oscillations of the manometer. Blood in the needle has naturally the same effect. By adhering to the golden rule never to let gas escape into the body before characteristic oscillations are seen, the risk of fatal gas embolism is reduced to a minimum.

When characteristic manometric oscillations are obtained, filtered nitrogen or air is admitted, the quantity not exceeding from 200 to 300 c.c. at the first injection. After taking the readings of the manometer the needle is withdrawn. No dressings are required. The injections should be repeated daily, or every other day, till the lung is collapsed and a positive intrapleural pressure has been obtained.

The apparatus. The water is seen standing in the manometer. The figures on the manometer scales represent centimetres. Each graduation on the bottles marks 100 c.c.

of refilling the pneumothorax with nitrogen. Forlanini's plan of introducing nitrogen between the two layers of the pleura through a fine, hollow needle, and thus inducing collapse of the lung, can now be carried out with ease in cases uncomplicated by adhesions, provided the operator carefully carries out every detail of the recently improved technique.

Technique of the Operation.

The apparatus and technique have undergone numerous

If adhesions are absent or easily broken down, several injections of 500 c.c. each may be required before the intrapleural pressure becomes positive, but if there are extensive adhesions the pressure will rise rapidly even after as small an injection as 50 c.c. In such cases, if the adhesions do not yield to repeated injections at high pressure, it is advisable to puncture elsewhere in the hope that another pocket of nitrogen may be formed and be more efficacious by acting upon the adhesions from another point. Such cases are most difficult and require infinite patience on the part of all concerned. After laboriously injecting 100 c.c. or less, the gas may come whistling out through the puncture as the needle is withdrawn, or it may cause surgical emphysema, which leads to great discomfort if the gas has tracked up along the fascia of the neck.

Even when a most imperfect pneumothorax has been obtained and respiratory sounds are audible over the greater part of the lung, the partial immobilisation of the lung may yet be capable of giving excellent results.

The intrapleural pressure that is necessary differs according to the extent of the lung's collapse: if it is complete a positive pressure of from 5 to 10 cm. of water is sufficient, and a greater pressure is liable to cause troublesome dyspnoea. Once, when refilling a pneumothorax in which the pressure had hitherto not exceeded 8 cm., I raised the pressure to 10 cm. This was enough to cause a slight attack of dyspnoea and vertigo when the patient sat up in bed a few minutes later. A colleague who, in inducing a pneumothorax for the first time, raised the intrapleural pressure to double the desired extent by an error in reading the manometer, induced such alarming symptoms of dyspnoea that the operation had to be reversed and a large quantity of nitrogen withdrawn. When, however, the pneumothorax is strictly limited by adhesions, pressures of from 30 to 40 cm. of water or more may be employed with impunity, care being taken to use a fine needle and to strap the chest over the site of the puncture to prevent surgical emphysema.

Suitable Cases.

The selection of suitable cases for the treatment is often a great difficulty, for the indications and contra-indications have been repeatedly altered as experience has been gained by different writers. The stipulation that one lung must be quite healthy would exclude nearly all advanced cases, and yet it is in this class that so many excellent results have been obtained. Provided that the prognosis is very bad, the worse of the two lungs should be compressed even when there is considerable disease in the healthier of the two lungs. It is often difficult to estimate the degree of activity of the disease in the healthier lung, and it may therefore be necessary to immobilise the worse of the two lungs to see whether the healthier lung is a cause of the fever or not. If after complete immobilisation of the one lung the temperature remains as high as ever, the other lung is convicted of considerable active disease in the absence of laryngeal and intestinal complications. Even if such a diagnostic pneumothorax proves the other lung to be gravely affected, the question is still an open one whether the treatment should be given up or not. Personally, I am in favour of continuing the treatment; if abandoned, it is depressing to the patient, who gives up all hope; if continued, the remaining lung may yet improve, and in the course of a year or two the compressed lung may again be allowed to expand, and then, if necessary, the other lung may be compressed. Advanced tuberculous conditions of the larynx or intestine were considered as contra-indications at one time; but latterly a number of cases have been reported in which compression of the lung was followed by the recovery of tuberculous lesions of the larynx. Where intestinal tuberculosis is associated with more or less constant diarrhoea little can be expected from the treatment.

Hitherto, in Scandinavia the cases treated have been principally those in which practically the whole of one lung was involved and the prognosis was almost hopeless. Little healthy lung tissue has thus been sacrificed. But with the experience and material now at our service it seems only fair that this treatment, so successful *in extremis*, should be given a wider sphere. Murphy and Lemke have, in fact, had good results among their patients in the first and second stages of the disease, and Mjöen in Christiania has published the case of a young labourer whose early disease he checked by a few injections of nitrogen after the usual sanatorium

treatment had failed. The dictum, "the unemployed of long standing are unemployable," is a strong argument in favour of a short cut to health, and an artificial pneumothorax, when supplemented by sanatorium treatment, may undoubtedly give quicker and better results than conservative treatment alone.

Before the treatment can be extensively applied to early cases of phthisis, or cases in which the disease is of old standing but of limited extent, two questions must, however, be answered. One is, What chances has the compressed lung of re-expanding when the injections cease? The other is, What are the dangers to life from gas embolism and pleural reflex? There is as yet insufficient material on which to base a reliable answer to either of these questions, and as long as this is the case many will prefer more conservative treatment.

Pleural adhesions, if extensive, prevent the formation of an efficient pneumothorax, but their existence can only be guessed at, and only repeated failures to reach a free pleural space are proof positive of their presence. In chronic disease with retraction of the thorax and displacement of the heart extensive adhesions are common, but not the rule, and even after frequent attacks of pleurisy an efficient pneumothorax may yet be obtained. Total pleural adhesion is very rare, and in a case of Dr. Jollye's, seen by Dr. Latham and myself, it has been possible to inject a considerable quantity of nitrogen in spite of pleurisy which has left basal adhesions. Forlanini at one time considered acute tuberculous disease of a lung as a contra-indication, for he held that the benefit derived from the treatment was mainly due to the removal of a disadvantageous mechanical factor by immobilisation of the lung, and that this is not sufficient to arrest the more rapid forms of phthisis. Experience has shown this assumption to be incorrect in many cases, and when early rapid phthisis is checked by the treatment, the chances of a successful recovery are even better than in the more chronic cases where the constitution has been undermined by many years of illness.

When phthisis is complicated by pleurisy with effusion good results are obtainable by replacing some of the inflammatory exudate by non-irritating nitrogen.

Treatment of Hæmoptysis by Artificial Pneumothorax.

The following case was communicated to me on July 4th, 1910, by Dr. Holmboe of Mesnali Sanatorium, Norway, and he has kindly permitted me to publish it.

CASE 1.—A young Swede had been kept to his bed with a subfebrile temperature for several weeks, with one lung extensively involved, the other nearly normal. Even after a slight hæmoptysis followed by a further rise of temperature he refused to have a pneumothorax induced as he hoped to make a natural recovery. One night a violent hæmoptysis occurred, reducing the patient in the course of ten minutes to a state of profound anæmia and collapse. In anticipation of this the nitrogen pump with adjuncts had previously been got in readiness. The skin was rapidly disinfected with tincture of iodine, and the needle was thrust into the chest as the hæmoptysis continued. 500 c.c. of nitrogen were injected, and as the intrapleural pressure remained negative a further lot of 200 c.c. was admitted. The cough and hæmoptysis ceased at once. On the following day about half an ounce of blood was coughed up, necessitating the injection of 500 c.c. more of nitrogen, which immediately stopped the bleeding. In spite of a temperature of 104° F. the patient began to rally; no further hæmoptysis occurred, and the temperature fell to normal. The injections are being continued, and there is every prospect of a good recovery.

The value of an artificial pneumothorax as a hæmostatic is further illustrated by the following case reported by Dr. Thue of Christiania.

CASE 2.—A workman, 32 years old, was admitted to hospital with hæmoptysis, which had lasted off and on for six days. During the following fortnight the hæmoptysis continued at irregular intervals, over one litre of pure blood, as well as much blood-stained sputum, being expectorated. The patient became very anæmic, the pulse was rapid and feeble. Both lungs were affected, but the left was much more extensively involved than the right. It was therefore assumed that the blood probably came from the left lung. A puncture was first made in the sixth space between the middle and the anterior axillary lines. No free space was found here, but a second attempt in the seventh space in the

mid-axillary line was successful, and 200 c.c. of nitrogen were injected. The hæmoptysis ceased at once, and the sputum on the following day was but slightly blood-stained. The injections were continued, and no further hæmoptysis occurred.

Hæmoptysis as a sequel to the treatment is conceivable, and it frequently happens that after the first injection, when the needle has penetrated the visceral pleura, the patient coughs up a small clot or two of blood. I have once seen a case in which profuse hæmoptysis occurred 24 hours after a vain attempt to inject nitrogen at four or five different points. Doubtless the lung was wounded more than once, but as no blood appeared at the time it is highly improbable that the hæmoptysis was due to injury of a blood-vessel by the needle's point. It is more likely that hæmoptysis was a coincidence, or that the excitement of the operation and its failure was followed by profound exhaustion which led to congestion of the lungs and consequent rupture of a blood-vessel. I have frequently noticed that violent exercise has been followed by hæmoptysis not on the same day, but early on the morning of the following day. A curious example of coincidence occurred some time ago when a colleague agreed to induce a pneumothorax in a patient whose parents withdrew their consent to have the operation performed. The day on which the operation was to have taken place the patient died from a violent hæmoptysis.

Saugman in his experience of over 50 cases has only twice seen hæmoptysis occur after the first injection. In the one case the hæmoptysis began before the treatment and continued until a sufficient number of injections had compressed the lung, when no further bleeding occurred. In the other case the pneumothorax had existed for some time, but a thick walled cavity had prevented the complete collapse of the lung. The hæmoptysis which caused death was found post mortem to come from a vessel in the wall of the cavity.

It has been shown by Bruns and Muralt among others that the blood-vessels in the compressed lung collapse, and that the anæmia in this lung is directly proportional to the pressure of the pneumothorax. The great drawback to the treatment is the uncertainty as to which lung is the seat of the bleeding, as bubbling râles due to the hæmorrhage may be heard over both lungs; but in a sanatorium where both lungs have been under observation for some time, the side from which the bleeding comes can generally be detected. To those who have stood by while hæmoptysis has continued in spite of every medicinal remedy, including the recently much vaunted amyl nitrite, this remedy will appeal in spite of its undeniable limitations.

Dangers of the Treatment.

There are a variety of dangers, such as empyema, hæmoptysis, tuberculous meningitis, and aspiration of pus from the compressed into the other lung, which may be caused by the treatment; but in practice these accidents are extremely rare. There remain two great dangers—pleural reflex and air or nitrogen embolism—each of which has claimed a number of victims.

Pleural reflex has been lately studied by Roch in connexion with an artificial pneumothorax. He induced it in animals by stimulation of the pleura by an alcoholic solution of iodine. Forlanini has obtained somewhat similar results, and has shown that the condition can be averted by anæsthetising the pleura beforehand. He therefore recommends an injection of stovaine in the neighbourhood of the pleura as a preliminary to an injection. In his analysis of 1454 thoracenteses performed in 1909 he has shown that the condition occurred four times, once only with serious consequences. Saugman, with an experience of 54 cases of artificial pneumothorax and 970 injections, has not seen one serious case of pleural reflex, and has only seen premonitory symptoms twice. He considers the absence of severe pleural reflex in his practice to be due to his avoidance of high intrapleural pressures, to his technique, and possibly also to the relatively stable nervous system of his Danish patients. His two cases of slight pleural reflex were associated with extensive pleural adhesions, which are undoubtedly provocative of pleural reflex, as they require high intrapleural pressure for their separation. Brauer has found a state of collapse follow the injection of too cold nitrogen, and he therefore warms the gas before injecting it. The operator should always be on his guard against pleural reflex, and be ready to withdraw the needle at the first sign of this condition.

Several deaths from air or nitrogen embolism have been reported in consequence of the treatment, and this accident has not been confined to first injections. In an early stage of the treatment the needle was connected with a cylinder of gas as the needle traversed the tissues. Gas embolism was therefore freely courted, and it is strange that the number of fatal cases is not greater. The improvement in technique, which includes the use of an aspirating syringe whenever the operator is in doubt as to the position of the point of the needle, has reduced the risk to a minimum, and by connecting the needle with the manometer and clamping the tube leading to the nitrogen, only the smallest quantity of gas can be drawn into a vein. Saugman estimates that at least from 20 to 30 c.c. of gas are necessary to cause fatal embolism, and such an amount is not likely to escape through the needle by accident. Brauer has reported a case in which instantaneous death followed the injection of 15 c.c. of nitrogen, but as no necropsy was allowed it is open to doubt whether death was due to gas embolism or pleural reflex. If the former hypothesis is correct it is still doubtful whether the nitrogen or inspired air entering a wounded vein was the cause of death, for it is possible, according to Brauer, that air embolism may be induced merely by the puncture of a vein which sucks in inspired air. Of the fatal cases reported, a few have had the diagnosis verified post mortem. In these death has followed sudden faintness, pallor, dilatation of the pupils with loss of reflex, facial paralysis, clonic and tonic convulsions, and loss of consciousness.

Faulty technique is probably to blame in a large percentage of the reported fatal cases, and in advanced cases of phthisis the risks of the treatment are relatively small compared with the risk of relying on more conservative methods. The risks require a more critical scrutiny, however, when the treatment is advised in cases of early phthisis with excellent chances of recovery by less heroic means.

The Choice of Nitrogen, Air, Oxygen, or Normal Saline Solution.

Atmospheric air possesses the advantage of always being obtainable, but it is absorbed more rapidly than nitrogen. Normal saline is advocated by Holmgren, who in four cases experienced greater ease in finding the space between the layers of the pleura with it than with nitrogen. Ad. Schmidt has, however, shown it to be unsatisfactory. Oxygen has also been advocated on the assumption that it would not cause dangerous gas embolism, but experiments on animals have shown this view to be incorrect.

Effect of the Pneumothorax on the Compressed Lung.

This lung may be completely immobilised if no adhesions exist, and no thick-walled cavities prevent its collapse. Such a condition rarely exists in advanced disease, the lung being usually adherent to a considerable area of the chest wall. When the adhesions are diaphragmatic or lateral, the beneficial effects of the pneumothorax are partly neutralised. Apical adhesions, on the other hand, are of little importance, as the drainage of the lung is still effective, and the partial limitation of the lung's mobility appears sufficient to arrest the disease. Such adhesions may even be of advantage as they prevent the cicatrization of the whole lung. The patient whose lung has become a mass of scar tissue has burnt his bridges most effectively, and should his remaining lung become the seat of active disease he is helpless, whereas if his compressed lung is capable of expansion he can compress the other. Forlanini has recently reported a number of such cases of alternate compression successfully treated.

In the majority of cases the compressed lung re-expands. The compression may have lasted for several years without affecting the lung's power of re-expansion, or it may have lasted only a few months, and yet the lung has become a mass of scar tissue with a thickened fibrous capsule. The conditions which favour the latter result include complete compression of the whole lung for a considerable time, an intrapleural pressure which is kept consistently positive, and pleurisy with effusion. The nature of the inflammatory condition of the lung is also an important factor, a chronic fibrotic process being more likely to favour permanent collapse than an acute process with little tendency to scar formation. Although pleural effusion aids the compression of the lung and may render its capsule thickened and fibrotic, it frequently fails to compress the lung permanently. It is impossible to promise the patient a functionally active lung

at the close of the treatment, although the chances of its return to full activity are considerable.

Effect of the Pneumothorax on the Uncompressed Lung.

The improvement observed in this lung is often rapid. Probably the most important factor in this change is the general improvement in health which follows the immobilisation of the compressed lung.

Apart from arrest of the disease in this lung, other changes have been observed, including emphysema and elongation of the whole lung due to the increased intrathoracic pressure. Several cases have been reported in which the disease in the remaining lung progressed after the compression of its fellow. In the majority, however, the spread of the disease in this lung is certainly in spite of, rather than because of, the treatment. Carpi has shown that the opsonic index assumes a more favourable level during and after the treatment.

Minor Complications.

A serous effusion into the pneumothorax has been recorded in about one-third of all reported cases. It generally occurs within six months of the first injection, and is usually associated with fever, lasting a few weeks and falling by lysis. It seldom fills the whole pleural cavity, and it is usually sterile, although in some cases intraperitoneal injections in guinea-pigs have produced typical tuberculosis. The effusion is almost invariably of tuberculous origin, and is not due to septic infection from the lung or the site of the punctures. If the effusion is great some of it should be withdrawn and replaced by nitrogen. It is necessary to watch such cases carefully, as the fluid may be re-absorbed rapidly and the lung may re-expand and become adherent to the chest wall.

Pain is often very severe during the first two or three injections when adhesions are being stretched. Morphine may in many such cases be required. Dyspnoea is inevitable at first, but it is seldom troublesome provided the intrapleural pressure is kept within reasonable bounds. When an effusion occurs it may be necessary to withdraw a certain amount in order to relieve this symptom. The treatment often increases the frequency of respiration from 20 to 30. When the uncompressed lung is considerably involved this rate continues, otherwise it falls below the rate previous to the commencement of the treatment and in some cases is as low as 18 or 16.

Tachycardia.—The pulse commonly gains in frequency at first; later, when the temperature has fallen, and the intrathoracic organs have adapted themselves to the change in position and pressure, it frequently falls to 70 or 80, rapidly rising again on provocation. When the frequency of the pulse persists, the prognosis is bad.

Surgical emphysema.—When superficial, it may be both extensive and troublesome, but it is never dangerous. By bandaging firmly over the site of the puncture it seldom spreads far. Deep surgical emphysema is far more serious, and in most cases where it occurs the leakage of nitrogen prevents the formation of an effective pneumothorax. The nitrogen may escape into the mediastinum, embracing the trachea and œsophagus. It may also extend to the submaxillary region, to the axilla, and down to the elbow. The subsequent dysphagia and the feeling of pressure in the chest are very troublesome. In such cases frequent small injections are required to avoid raising the intrapleural pressure too violently.

Dyspepsia.—This condition is, curiously enough, most frequent and pronounced in pneumothorax of the right side. Patients also suffer frequently from nausea and inability to eat much at a time. Saugman and Begtrup Hansen have called attention to the fact that marked dyspepsia and nausea are frequently precursors of a pleural effusion.

When to Discontinue the Treatment.

This is a question to which no definite answer can be given at present. Cases in which the treatment was concluded after eight months or less have frequently ended disastrously, for not only has the disease flared up again as the lung re-expanded, but attempts to re-introduce nitrogen have failed owing to extensive pleural adhesions. The danger of cutting off the patient's retreat is therefore very great if the parietal and visceral layers of the pleura are allowed to come in contact with each other again. Fortunately the

pneumothorax can be maintained by refilling the pleural cavity every month or two according to the rate of absorption of the nitrogen in each case without incapacitating the patient from light work.

Value of X rays.—From first to last the X rays are of great value both in the selection of suitable cases and in controlling the results of the injections, but they are not an absolute *sine quâ non*.

Results.

Both Brauer and Saugman insist on the inadvisability of relying on a purely statistical analysis of the results, for a detailed knowledge of the gravity of each case is necessary for the full appreciation of the treatment's value. There is also great variation in the results obtained by different writers, for the selection of cases has not been based on the same principles by all. Some have induced a pneumothorax on one side when the disease has been extensive and active on both. Others have included in their statistics all those cases in which the treatment was abandoned after a few vain attempts to form an efficient pneumothorax. Laryngeal, intestinal, and renal tuberculosis have frequently caused death in patients whose compressed lungs showed no active disease at the necropsy. The total death roll, therefore, of patients who have undergone the treatment is heavy, and is liable to discourage those whose estimation of the treatment's value is based only on figures.

Holmboe has reported 2 cases, both of which were successfully treated. Thue has reported 11 cases, with good results in 5. Mjöen has reported 10 cases, with good results in 5. Würtzen and Kjer Petersen have reported 21 cases (in 7 of these no pneumothorax could be induced, and in 7 others it was strictly limited), with permanent good results in 3.

Saugman and Begtrup Hansen have reported their first 33 cases. These cases are divided into three classes.

Class 1.—Six patients in whom extensive adhesions prevented the formation of an efficient pneumothorax. The treatment was abandoned without having done any harm. The small pockets of nitrogen which were formed appear even to have been temporarily beneficial, for the temperature fell in 2 cases, bronchial respiration disappeared for good in another case, and in yet another the bacilli disappeared for the time from the sputum.

Class 2.—Three patients in whom extensive disease in the healthier of the two lungs rendered the outlook almost hopeless from the start. In one case the pneumothorax was induced in the hope that râles heard over the one lung were conducted from the other. The treatment showed this assumption to be incorrect.

Class 3.—Twenty-four patients in whom an efficient pneumothorax was induced and maintained. The majority of these improved, the improvement being permanent in 11. The causes of failure in the remaining 13 patients were as follows. Progressive disease in the remaining lung in 4, laryngeal disease in 2, intestinal disease in 4, cardiac complications in 1. In one case which was progressing favourably the pneumothorax disappeared owing to the unexpectedly rapid absorption of the nitrogen; the adhesions which formed prevented the continuation of the treatment. One patient died from secondary hæmorrhage after an operation for separation of pleural adhesions.

Forlanini in a recent lecture on the treatment does not state how many of his patients (86) were cured, but the whole tone of the lecture suggests that the results were eminently satisfactory.

Gorleston-on-Sea.

UNIVERSITY OF LIVERPOOL.—A Diploma in Ophthalmic Surgery has been established by the Council of the University of Liverpool on the recommendation of the Senate and the Faculty of Medicine. The diploma (to be styled "D.Ch.O") will be awarded after examination to candidates who possess a qualification or diploma in medicine entitling them to registration in the United Kingdom, and who have attended a three months' course of study in the anatomy, physiology, and pathology of the eye in the University, and a three terms' course of instruction in a recognised ophthalmic clinic, subsequent to qualification.