

THE SURGICAL TREATMENT OF ACUTE AND CHRONIC EMPYEMA.

BY MAURICE H. RICHARDSON, M.D.,

BOSTON.

THE remarks which I have to make upon the subject of empyema and its surgical treatment are based upon an experience now quite extensive in the surgery of the thorax. So much good work has been done and so much written upon this branch of surgery that it was with great hesitation that I accepted your President's invitation to present a paper in which it seems to me quite impossible to say anything which has not been said many times before.

The brilliant results which attended the first antiseptic operations for acute empyema made this field of surgery, fifteen years ago, one of the most attractive and interesting. While acknowledging fully the importance of cleanliness and antiseptics in the treatment of acute empyemas, I maintain, nevertheless, that quite as important an advance was made in the modification and in the completeness of drainage; in other words, that the improved ideas of drainage played quite as important a part as the introduction of antiseptics. The first thing noticed in the new treatment was a marked diminution in the time required for the expansion of the lung and the obliteration of the pleural cavity. That this was due entirely to the use of antiseptics cannot be maintained, because, no matter how careful the technique and the efforts at cleanliness, it is evident that the lung cannot expand unless the drainage be good. The introduction of one or more large drainage tubes, the free evacuation of the contents of the cavity—perhaps aided somewhat by the manner of the application of the dressing—all together have enabled the compressed lung quickly to expand and close the pleural cavity.

Believing that all cases of empyema are surgical, and should be treated surgically, I shall not spend any time upon the methods of treatment by aspiration. I consider them unjustifiable and unsurgical, and believe that valuable time is lost by their application. At the same time, I should acknowledge that occasionally this method is successful.

The pleural cavity should be drained as soon as the diagnosis of empyema has been made. Dangers in delay consist not so much in menace to the life of the patient from constitutional disturbances, as in the liability of the lung to form adhesions or to become diseased while contracted so as to make expansion difficult if not impossible. It is for this reason that immediate drainage is imperative in all cases of purulent pleurisy.

In the preparation of patients for permanent drainage, great care must be taken in rendering the field of operation aseptic. The method which I use is as follows: At least twenty-four hours before operation the skin is scrubbed with soap and water, and a layer of cotton-batting wrung out in hot solution of soap is applied. This is kept on twelve hours. The poultice is then removed and the skin washed in ether. Another poultice of corrosive sublimate, 1-3000, is applied and kept on until the time of operation.

General anaesthesia should not be used unless absolutely necessary. This is not only on account of its inherent danger, but also because it is very desirable to have the patient cough while the cavity is being emptied. While conscious, he is able also to express impending danger, as shown by subjective symptoms. This is so true of aspiration that no one would think of giving an anaesthetic for the purpose of thoracentesis. Another advantage in having the patient conscious is that he can make voluntary efforts at coughing. This serves to expel the pus and also to expand the lung. Lung expansion from coughing or crying I have been able to observe in several cases where a large incision had been made and a portion of the rib removed. By reflected light it was quite possible to see the lung expanding during the evacuation of the cavity so rapidly as nearly to close the pleural sac before the application of the final dressing.

In the usual form of empyema where the whole pleural cavity

is involved, the place of incision should be selected with reference to the case becoming chronic. If total obliteration of the sac takes place in the course of a few days, it makes little difference whether the drainage tube be put low down in the pleural cavity or not; whether in the eighth, ninth, or as high up as the fifth or sixth space. If, however, the case prove to be a chronic one, the lungs do not expand, and the cavity becomes closed by the usual method of collapsing walls, then the drainage tube should have been placed higher up, otherwise the lifting of the diaphragm makes drainage difficult and a higher incision necessary. It is better, therefore, to consider all cases as possible chronic ones and make the incision in the sixth or seventh space. It is better to make the opening in front of the latissimus dorsi in the axillary line than through the fibres of that muscle, or far enough forward to interfere with the pectoralis major. There is no objection to an incision through the latissimus dorsi except that it disables that muscle; it is deeper, bloodier, and offers no advantages whatever over the comparatively shallow incision necessary in the axillary line. The great objection to an incision in front of that line is the proximity to the heart and the greater difficulty attending drainage in that region.

An incision through the tissues into the pleural cavity may be made freely and quickly by means of a sharp bistoury, or it may be made upon the needle-pointed trocar devised by Dr. Cabot. The advantage of this trocar is that one is assured of the presence of pus before the knife is introduced. This is a very neat and a very expeditious method of opening the pleural cavity. Another method is the introduction of a drainage tube through a trocar-canula. This method is unsurgical, incomplete, and should not be employed unless a trocar of such great size is used as to permit the introduction of a large drainage tube. The use of this method results in the introduction of a drainage tube so small as to be of no value. Finally, we have the method of free incision. This is to be preferred in all cases where the patient's condition justifies the time necessary for its performance, and consists in a cut two or three inches in length down to the body of the rib itself, and parallel with it. An inch or more of rib is separated from its attachments, lifted from its bed, and excised.

The pleural cavity is then opened by a longitudinal cut at the bottom of the space occupied by the excised portion of rib. By this method the intercostal arteries and nerves are avoided and most satisfactory drainage established. The drainage tubes are next introduced and the contents of the pleural sac allowed freely to escape.

The tubes should not be less than a quarter of an inch in total diameter. Two of these of rubber, placed side by side in the method first described by Dr. Cabot, and fastened into a shield, make a drainage with which no fault can be found. The tubes may be fastened together by a safety-pin, or may be sewed into the shield with one or two stitches. It being necessary frequently to change the tubes for purposes of cleanliness, several sets should be used. When not in use the tube with its shield should be left in an antiseptic solution after having been thoroughly washed. On the whole, the rubber drainage tube is the best, although it has some disadvantages.

The dressings for an acute empyema should consist of sterilized gauze and absorbent cotton. They should be large enough to absorb, without staining, the discharges of at least half a day. If it is not considered desirable to establish a valve action, either in the dressing or in the tube, it makes no difference how they are applied. It is well to make the layer next the skin of sterilized cotton, and to cut out a small space into which the projecting ends of the tubes fit. This prevents obstruction to the discharge, and also pain from the direct pressure of the bandage. If the lung does not expand, tubes with valves may be used to create a vacuum, by the pressure of which expansion may be promoted. The first which I used was difficult to keep clean, and the valve action, though quite satisfactory, interfered with drainage. The most effectual valve that I have ever used, and one which theoretically answers the purpose to perfection, is made by covering the small dressing which I place about the tube with rubber pellicle. The ends of the tubes beyond the shield are left about an inch in length. A dressing of some greater thickness than this, with a circular place about two inches in diameter cut out, is placed about the tubes. Over this part of the dressing, which is absorbent cotton, a sheet of rubber pellicle

about six inches square is placed. Inspiration sucks the pellicle down upon the tube openings and no air can enter. Expiration is perfectly free and unimpeded. By this method it is absolutely impossible for air to enter, unless the dressing becomes deranged. A most perfect valve action is established. Theoretically this would seem to be a most desirable thing. Unfortunately, experience does not justify one's expectation. A few efforts at coughing produce a vacuum in the pleural cavity greater than can be satisfied by the expansion of the lung. This causes a constant suction upon the valve, nothing escapes, and the intra-thoracic pressure has to be satisfied by the exudations from the inflamed pleura. When a sufficient amount of pus has formed to overcome the vacuum pressure, it will begin to escape. It is quite evident that this state of things is most undesirable. Abundant clinical evidence has convinced me that the lung will expand not only without the aid of valves, but in spite of any impediment that may be placed in its way. In the majority of cases, especially in children, it is impossible to retain the tube in position after a certain time; the lung expansion forces it out. In many carelessly attended cases the tube has been forced out in spite of efforts which are made on the part of the physician to replace it. Unfortunately, in a great many cases of empyema, the opposite is true; the tubes are taken out too soon and pus re-accumulates. It is much better as a rule, therefore, to leave the tubes in until they are so forced out that they can no longer be replaced than, by their too early removal, to bring about a re-accumulation of pus with its renewed and increased constitutional disturbance. An opening so large as to permit perfectly free circulation of air during the movements of respiration is followed by quite as rapid recovery as the most effectual valve dressing or valve tube. This method is of great service, however, in those cases where for any reason the lung does not expand by the ordinary efforts of respiration.

In free incision and drainage there is less danger than in aspiration. It is quite evident that where a large amount is being drawn off by suction, the state of equilibrium existing between the displaced or contracted thoracic viscera may be seriously disturbed, and the patient may thereby be in great danger. The use

of the aspirator exerts upon the displaced heart and the contracted lung more or less pressure. To satisfy the vacuum the unyielding thoracic wall necessitates a shifting of all the thoracic viscera towards their normal position. The heart becomes violently replaced, and the lung must make excessive efforts at expansion. If the heart has become fixed in its new position, and if for any reason the lung cannot expand, we have a state of extreme commotion in the thoracic cavity which may be attended by alarming or fatal consequences. On the other hand, when the thoracic cavity has been freely opened by the introduction of a large drainage tube, or by the removal of a portion of rib, the pus escapes at first in a stream, being under more or less pressure. As soon as the intra-thoracic pressure has been relieved, there is equilibrium. No pus goes out, nor does air go in. In a short time, however, air enters with each movement of inspiration and a corresponding amount of pus escapes. At the latter part of the operation, the air rushes in to fill the space left by the evacuated fluid, and a state of equilibrium is maintained in which the patient is exposed to no danger. In my experience none has attended the numerous permanent openings made. In a comparatively small number of aspirations I have repeatedly seen most violent symptoms.

The thoracic cavity having been freely incised, and there being no check whatever to the evacuation of pus or to the entrance of air during the movements of respiration or of coughing, the moment for expansion has arrived. At this time it is important for the patient to cough or to make violent contractile efforts upon the thoracic cavity. The mechanism of lung expansion is very important, and its success depends almost entirely upon a perfectly free drainage. In the involuntary acts of coughing or sneezing, as well as in the voluntary expulsive efforts of the abdomen, the closure of the glottis plays an important physiological part. In the beginning of a cough or a sneeze, and during voluntary abdominal contractions, the glottis is closed and the thoracic cavity is contracted. When pressure is exerted upon the healthy lung, with a closed glottis, air rushes across the trachea into and through the primary bronchus of the other side, and the lung is expanded. This is shown clinically during the operation by the jets of pus

which escape during the involuntary coughing which is almost always set up by this procedure. Later, as the pus is being evacuated, air escapes. With each effort at coughing the lungs become more and more expanded; and at times during the manipulations of the operation itself the pleural sac becomes nearly obliterated. That the lung does not completely fill the cavity at once, is due to the fact that there is nothing to keep it expanded, except the adhesions which form between the opposing pleural walls. Several days are necessary for these adhesions to become strong enough to maintain the expanded lung firmly against the thoracic wall. That the lung should expand at all, or that it should stay expanded, has always seemed to me a remarkable thing. It is suggestive of a body being lifted in the air and kept there without support. In the formation of adhesions, however, we must find the explanation for this phenomenon, and anything that will hasten such formation is to be desired. It is in this that the use of antiseptics has its most important bearing. The absence of septic pus formation makes it possible for the inflamed pleural surfaces quickly to become united, and for the whole pus cavity to become obliterated.

At the close of an operation for acute empyema, one should be able to hear air going in and out with the movements of respiration. So long as the air does not do this, the operation is not complete, and the case is not likely to be one of quick recovery. It is quite evident that if anything blocks up the tube, or if the air cannot enter with perfect freedom during the efforts of respiration and coughing, the lung will be impeded in the process of expansion. For this reason the drainage-tube must be large enough to allow a perfect circulation of air.

If the drainage of the pleural cavity is perfectly free, washing out with any solution is of doubtful efficacy. The truth of this statement is seen in the effect of injecting a large quantity of water. In such cases it is obvious that the recently formed adhesions between the pleural surfaces will become separated. It is a good rule to follow, that large injections into the pleural cavity should not be used, except when the discharge has a bad odor. If injections are used for the purpose of washing out pus, this is a sufficient reason for additional operative interference and

the establishment of better drainage. Irrigation solutions are dangerous if we use any except the non-poisonous ones. Where there is an odor, a solution of chlorinated soda, not stronger than one part to ten parts of water, should be used. This is one of the best injections that I know of. It is absolutely harmless, and it destroys the odor more quickly than any other. Styrene, 1-200, in my experience, has given excellent results. The solutions originally used, especially of carbolic acid, are extremely dangerous, and I discarded them long ago. Carbolic acid poisoning was present in many of my early cases, and in one or two exerted a very unfavorable, if not a fatal, influence. This is true not only of the washing out of the cavity with a solution of carbolic acid, but in the simple application of dry carbolic dressing. The free circulation of air through the dressing and into the thoracic cavity has been followed by the volatilization of carbolic acid and its subsequent absorption through the pleura. In one case no carbolic acid whatever was used except on the instruments. This, in a child, was followed by the usual symptoms of carbolic acid poisoning. Washing out the thoracic cavity, therefore, except as mentioned above, should not be employed. In case, however, there are clots of fibrin or other semi-solid bodies in the pleural sac, boiled water should preferably be used. The pleural surfaces absorb with great rapidity, and all poisonous solutions, for this reason, should be avoided.

Occasionally the operation, especially if it be done blindly by one incision through all the layers over the intercostal space, is followed by profuse hemorrhage. The only place in the intercostal space free from artery is in the middle. The superior branch of the intercostal artery runs directly in the groove on the under surface of the rib, and the inferior branch upon the upper surface of the lower rib, either of which may cause considerable hemorrhage. This may easily be controlled by the use of a drainage tube so large as to cause pressure upon the surrounding parts, or by packing about the tube with gauze.

The intercostal nerve may be compressed by the tube, and a severe neuralgia follow. The pain is generally transitory, and is often referred to the terminal branches of the nerve, or may correspond to its distribution.

The most important element in the prognosis of acute empyemas, treated surgically, is the family history. Where there is a strong taint of tuberculosis in the immediate family of the patient, lung expansion will probably not take place. The prognosis depends also upon the length of time during which the lung has been compressed. In several of my cases the pleural cavity had been distended by pus for months. In such, although it is not impossible for the lung to expand, yet the chances of a favorable issue are not good. This is especially true if there be the slightest tuberculous taint.

The prognosis is good as to recovery from the immediate effects of the operation when performed early; but the remote mortality is necessarily large. Many of my operations were performed when the patient had been so much reduced in strength that death seemed a matter of a few hours. Under such circumstances it was necessary to open the thorax with the least possible shock. It would not be fair to say that in such cases fatal results were due to the operation.

CHRONIC EMPYEMA.—In the treatment of chronic empyema I shall consider how art may aid nature in shortening the exhausting and dangerous process of long-continued suppuration which inevitably occurs in all cases where, for any reason, the lung fails sufficiently to expand and close the pleural cavity. The changes that take place in the thorax and its contents, where nature unaided tries to effect a cure, when after drainage the lung has failed to expand and a large cavity remains, are well illustrated by the following case: —, a man of thirty-five years, was attacked in June, 1881, with acute pleurisy accompanied by a very large effusion into the left pleural cavity. The family history was not good, his sister having died of consumption. He was aspirated once or twice by Dr. Bowditch, and a very large amount of serous fluid was drawn. His symptoms were extremely grave, dyspnoea was excessive, heart much displaced, and constitutional symptoms severe. Early in July I withdrew by aspiration eighty ounces of cloudy fluid which contained a small amount of pus. No permanent relief following, and his symptoms increasing in severity and causing serious alarm, a free incision

and permanent drainage were advised. This was done with great care on July 19, 1881. The lungs did not expand, though long-continued efforts were made to bring about this result. A very large cavity existed up to June, 1885, with a daily flow of about two ounces of pus. In June, 1885, the size of the cavity was very much less than at first, the left side of the thorax having fallen in considerably, the right lung greatly expanded, and the diaphragm arched high up into the thorax. Nature had done everything up to that time to obliterate the space between the lungs and the ribs, and nothing prevented the skin and soft parts from sinking in and filling up the space except the firm and unyielding bony walls. This case shows the prominent features of an unfavorable case of empyema.

Up to 1879 no radical operation had been proposed to effect a permanent closure of such a cavity by surgical measures. Before 1876 several writers suggested the operation of resection simply as a method of free drainage, with the exception of Simon, who observed the effect of the operation as a means of causing the chest wall to collapse and thus diminish the size of the cavity. Simon's observation was confined to those cases in which but one or two ribs had been cut. Up to 1879 no operation had been performed upon the ribs with the purpose of contracting the chest wall. In 1879 Estlander published an article on resection of the ribs in chronic empyemas,¹ in which he advocated the removal of ribs for the purpose of allowing the chest wall to collapse upon the contracted lung. This operation, which has since been known as the thoraco-plastic operation of Estlander, consisted in the removal of from three to six, and sometimes more, ribs, sub-periosteally, below the axilla, where there are no large muscles. He gave in detail eight cases where the operation had been done by himself. The ages of the patients varied from twenty-one to fifty-six years, and the duration of the disease from three months to twenty. In all the cases the usual antiseptic opening had been made. There was abundant discharge, and their general condition was not good. These cases resulted in five recoveries, two deaths, and one uncertain. Est-

¹ Nord. Med., Stockholm, 1879, 11, No. 21, pages 1 to 14.

lander's method of operating consisted in exposing two ribs by longitudinal incision over the intercostal space, incision through and removal of the periosteum, and cutting through the ribs with strong bone forceps. If more than two ribs were resected, another incision similar in position and extent was made. Having exposed the thickened pleura, a small opening was made through the periosteum, which was dilated with Bigelow's dilator. There was seldom any hemorrhage, and that ceased when the rib had been raised from its bed. The only difficulty experienced was where the ribs were so close together that it was almost impossible to get between them. In such cases he used an elevator. In one case he made a vertical incision and several cuts at right angles to it, making a long and tortuous channel difficult to drain. Speaking of the cases in which long-continued suppuration had reduced the patient to an extreme degree, and which one might consider bad subjects for resection, he says that the operation causes very little disturbance and but little pain, and finally he sums up his article by saying that resection should be done while the lung is in great part contracted and the ordinary methods of free incision and antiseptic injections have failed; but not, however, until the pleura has become much thickened, which condition he considers essential for safety and cure, and not in any case where the patient may otherwise be diseased, either by amyloid or tubercular changes in other viscera, so as to preclude the possibility of recovery. Estlander also speaks of making several cuts in the ribs at intervals along their extent in order to provide for still greater powers of retraction in the bony wall.

Since the original article of 1879 this operation has been done by many surgeons and many cases have been reported. Several modifications have been proposed. The most important is that of Schede. In some cases the excision of ribs, as proposed by Estlander, for some reason does not result in the entire closure of the cavity. In such cases Schede has removed the whole thoracic wall in front of the cavity and brought the skin in contact with the pulmonary pleura. Sprengel, in Dresden, proposed a modification of Schede's operation. This method consisted in removing two ribs sub-periosteally in nearly their whole extent,

in making a long cut through the costal pleura as far as the limits of the empyema, parallel with the ribs, and then in clearing out the cavity of the empyema thoroughly with a sharp curette and tamponing with antiseptic gauze. Further healing of the case was left to nature, and took place by the shrinking of the pleura and the drawing in of the skin from all sides. A perfect cure resulted, though of course the function of the lung could not be restored. During the process of cure the skin was drawn so far into the cavity that it lined a part of it. The raw surface between its edges healed by granulation and cicatrization. In Schede's operation the pleural surfaces are also scraped, and the adherence of the skin to the lungs causes a boat-shaped depression in the chest wall. Up to the present time the above methods are the most important in these cases of long-existing cavity.

A cavity in the pleura may be of long standing, owing to insufficient drainage. Such cases are not rare and generally require the removal of portions of one or more ribs. Such a condition of things is seen after the permanent opening has been made and the tubes removed before the cavity has fully healed. Where the tubes have been in for a very long time, a growth of bone will be found on adjacent sides of contiguous ribs which may be so extensive that it will be found impossible to dilate the sinus sufficiently for the evacuation of the cavity.

The second, and by far the most important indication for resection of portions of several ribs, is found where the cavity has existed for a long time and the process of contraction has come to a stand-still. In such cases the expansion of the lung, contraction of the chest wall, and arching upward of the diaphragm have diminished as much as possible the size of the cavity, and yet one remains large enough to keep the patient reduced in strength, and, by its free suppuration, to be a constant menace to life from the ever-present danger of tuberculosis and amyloid changes in other organs. It is here that we must look for the most urgent indications for extensive resection of the chest-wall. It is my experience in cases of purulent pleurisy that a family history of tuberculosis is a most important element in

the prognosis. If there be a direct family influence in this direction, the chances of recovery after permanent opening, with complete closure of the pleural cavity, are extremely small. In a large number of cases of empyema, opened early in the disease, there has been no recovery where there has been such family taint. It does not follow, and it has not been my experience, that a good family history renders the result unqualifiedly good, but the number of failures is very small indeed.

This operation is contra-indicated in all cases where the lung is hopelessly diseased, or where amyloid changes have appeared in the liver, kidneys, or spleen. In some cases the strength of the patient may be so reduced that he cannot safely undergo the shock of resection. In this, as in all surgical operations, there must be a careful exercise of judgment and common sense, and the patient should not be advised to run a risk too great for his strength, without careful consideration of the chances of recovery from the immediate effects of the operation itself.

Before deciding upon the number and extent of ribs to be resected, the cavity should be studied with great care. The shape and extent vary greatly. In some cases there is a shallow cavity which is as extensive as the chest-wall itself. I have found that at times the sound goes upward as far as the apex of the lung and downward and inward to the centre of the diaphragm. The lung will be found to be symmetrically contracted in all directions, though the depth of the cavity may not exceed one or two inches. In other cases, the upper part of the pleura will have been filled up by expanded lung and a shallow cavity will exist corresponding to five or six of the lower ribs. As a rule, the lowest ribs will be shut off from the cavity by the raising of the diaphragm. In other and frequent cases, the cavity is quite circumscribed, and requires but a small incision and limited resection to close it. In the cases where a very extensive cavity exists, the depth will sometimes be found to exceed an inch or two, and even be so great that we must conclude that the lung has failed to expand at all. Resection in these patients will accomplish nothing but a diminution in the size of the cavity and a lessening in the amount of pus, without effecting a perfect cure. An operation, to be successful, must be very extensive indeed. It is in

such cases that Schede proposed to remove the chest-wall and bring the skin in direct contact with the pulmonary pleura. Under such circumstances, I believe that resection should be first performed in Estlander's way, and, if necessary, a more radical operation done later. This is better, also, because it will be found that the patient's strength will improve, after the first operation, sufficiently to enable him to undergo the second and more severe one with much greater chance of immediate safety and ultimate success.

In studying the technique of this operation, we must bear in mind the mechanical process by which the size of the cavity is to be diminished. If we take out a portion of one rib an inch in length, on the cadaver, we find that it will be impossible to bring the cut ends together, although we may approximate them slightly. The cut ends will sink in as far as the attachments of the intercostal muscles admit, which will not be far. If we take an inch from two ribs, the amount of depression and consequent approximation will be a little greater. If we take an inch from six or eight ribs, the amount of depression and approximation will be so great that the cut ends can be easily brought together, and the pleural cavity very much reduced indeed. The amount of reduction will depend more on the number of ribs resected than on the length of the excised pieces. When two or three inches are removed and the cut ends brought forcibly together, the chest-wall sinks in upon the lung so freely that it is very evident that a cavity of great size may in this manner be immediately obliterated. The total lessening of the circumference of the thorax is proportional to the number of ribs resected and the amount taken. I have shown this fact by resecting from four to ten ribs on the cadaver and observing the manner in which the ribs sink in. The sternal ends move upon their cartilages and will sink into any depth. The vertebral ends move upon their articulations and do not become so easily depressed. In some cases, especially in adults, there is so much stiffness that considerable effort is necessary to make the ends fall to the desired depth. In order to force these extremities into the required position, a good suggestion was made by Dr. Monks during my observations upon the cadaver, which as yet I have had no opportunity of using upon

the living—namely, that the divided ends be forced together and kept in position by means of wires. This would insure the immediate diminution of the size of the cavity, and it could be seen at once whether the operation had been thorough enough. In all cases where the ribs are not forced into the desired position, they sink in of themselves. I have no doubt, from my own experience, that they do not become depressed in this way as much as they might, and that in some cases new bone is formed before the cavity is entirely closed, which, after a time, will prevent the further contraction of the chest.

I have used all the incisions recommended and have come to the conclusion that the best, in most cases, is the vertical cut. If there be an old sinus remaining from a previous operation, it will be necessary to make an incision over the intercostal space in which it lies, in order to take out the rib above and below. All the other ribs can be reached with the greatest ease by carrying up the vertical incision. It is seldom necessary to carry it downward because the bottom of the cavity is almost always at the sinus, or even above it, if the space selected were below the seventh. By this incision any number of ribs may be exposed, and sufficiently large pieces removed.

In considering how long a piece of rib to remove, we must return to the mechanical process by which the cavity is to be closed. If the thorax were, on horizontal section, a perfect circle, it would be very easy to say how much must be taken from the length of the rib to allow the cut ends to meet at the required depth. Taking into consideration the shape of the thorax and the obliquity of the ribs, I have found that approximately the length of the excised piece should be about the same as the depth of the cavity, where this is extensive and symmetrical.

Whatever method be selected, the operation should not be performed for at least six months after the primary incision. The lung should be allowed to expand as much as possible, and the other means used by nature given a fair trial. When all has been accomplished that can be expected, unless there are signs of failing strength or amyloid disease elsewhere, resection should be advised.

Where one rib is to be excised there should be a cut over the

rib itself three or four inches in length, down to and through the periosteum along the centre of the bone in its long axis.

In extensive resections, the length of the pieces having been previously determined by a careful study of the cavity, a vertical incision should be made in the axillary line long enough to include all the ribs to be excised.

The periosteum of the ribs above and below the sinus is incised longitudinally and lifted upward and downward, so that the vessels, nerves, and pleura are separated with it, and saved from being injured by the cutting to follow. It is very difficult to raise the ribs above and below the sinus, because new bone frequently forms about the tube-hole and unites them firmly together. Having once succeeded in separating and lifting these two ribs high enough to introduce the bone forceps, the first cuts are very easily made, and the pieces of bone removed. The other ribs can now be resected with great rapidity and ease. A great deal of time is saved by the use of strong bone-cutting forceps. They do not splinter the bone if they are sharp and closed suddenly with great force. If they are closed slowly, or if they are not sharp, they crush rather than cut the bone, and necrosis of the ends may follow.

This method is simple, and its constitutional effects are very slight. I have used all the incisions recommended by others and two of my own. The first case by one longitudinal cut; the second by two longitudinal cuts; the third by two long vertical cuts without any transverse ones; the fourth by one vertical cut from which four ribs were easily taken, and one long vertical cut from which four also were taken. In all later operations I have used the vertical incision. It is very easy to remove four ribs through one cut, either longitudinal or vertical. I prefer the vertical cut as giving better drainage.

The use of the chain-saw is not necessary, and it makes an operation very long which should be very brief. I have not made a counter-opening in any case, though I should do so when the diaphragm is raised so as to make the channel of drainage long and difficult. In such cases it is best to make a small opening and dilate with Bigelow's dilator, to avoid the hemorrhage that would follow free incision through the enormously thickened pleura. It is very important that drainage should be perfectly

free. The largest-sized tubes should be used, and two of them. This operation, if it does nothing else, provides a drainage so free that it would be difficult to obstruct it.

The immediate results in operations for chronic empyema are very gratifying. There is, even in cases which are not ultimately cured, a marked diminution in the discharge, so that after the operation, as the chest-wall sinks in, the amount of pus steadily diminishes, and either disappears entirely, or, at the end of a few weeks, reaches a small fixed daily quantity. It is possible, therefore, to determine very soon just how successful the procedure has been. If a cure has not been effected at the end of six or eight weeks so that the discharge has practically ceased, a question of further and more extensive resection must be considered.

The remote results I have been able to follow in many of my cases. In most, the cure has been permanent. In two cases there has been a recurrence of the disease after several years of health, and death from tuberculosis.

For a shallow, symmetrical cavity, such as is usually found in cases of chronic empyema, the resection of from two to eight ribs, after the method of Estlander, will be quite sufficient for its complete obliteration. For those enormous spaces left when the lung fails to expand at all, one may have recourse to the formidable procedures of Schede and others, but only in the absence of tuberculous diseases of the lungs or amyloid changes elsewhere. Even if everything be favorable for the operation, it must be borne in mind that the immediate mortality in such cases is large, and that a successful result is quite doubtful.

DISCUSSION.

DR. ALFRED L. LOOMIS. I can fully indorse all methods proposed for the treatment of empyema in the paper just read. In my opinion the principle which Dr. Richardson inculcates, as regards the opening in the chest, is the only safe one, and the only one which will be found satisfactory in a large number of cases. The management of acute empyema is generally not

difficult if the opening is made early. But in chronic empyema you have a different condition of affairs, one in which the future of the case, after the operation, it seems to me, depends altogether upon the extent of the connective-tissue formations in the pleural cavity. It seems to me that this decides the final result in all those cases.