Closed Intrapleural Pneumonolysis

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INTRODUCTION

In 1882, Forlanini\textsuperscript{12} of Milan proposed the induction of artificial pneumothorax in patients suffering from pulmonary tuberculosis, and in 1894\textsuperscript{13} he published his experience with the first patients to be submitted to this form of therapy. In 1885 Cayley had reported the case of a tuberculous patient in whom he had induced pneumothorax by open incision of the chest wall to control hemothysis, and in 1888 Potain, who used a manometer to measure the intrapleural pressure, published work on air replacement in tuberculous patients who had suffered spontaneous hydro-pneumothorax. Forlanini, however, was the first to induce pneumothorax with the objective of controlling the tuberculous process in the diseased lung itself. Following Forlanini, the next significant advance in artificial pneumothorax therapy was due to J. B. Murphy of Chicago, who in 1898 urged the use of radiology to control the degree of collapse. With the routine use of the manometer by Saugman in 1904, the technique of artificial pneumothorax was placed on a sound basis, and by about 1910 this procedure had begun to take its place as an established form of therapy in pulmonary tuberculosis.

Early in the history of artificial pneumothorax the significance of pleural adhesions in preventing effective collapse was recognized, and in 1894 Forlanini\textsuperscript{12} wrote that "the pleural adhesions limit the volume of the pneumothorax and therefore its curative value." Matson,\textsuperscript{19} from an experience of 1,500 patients suffering from pulmonary tuberculosis treated by artificial pneumothorax, found that 40 per cent of failures were due to pleuritic adhesions which prevented satisfactory collapse. Alexander\textsuperscript{2} states that diffuse adhesions prevent induction in about 20 per cent of attempts at artificial pneumothorax, and that in approximately 42 per cent to 50 per cent of cases adhesions allow only partial pneumothorax, insufficient to bring about complete healing of the lesion.

It was inevitable, then, that attempts to devise methods of freeing adhesions should be made, and in 1908 Freidrich of Marburg divided adhesions through an incision made into the pleural cavity; this operation, known as open intrapleural pneumonolysis, continued to be practised for a number of years, but owing to the
high incidence of serious complications, "died," as Newton\textsuperscript{21} has put it in discussing this procedure, "a natural and deserved death."

In 1913, Hans Jacobaeus of Stockholm devised the operation of closed intrapleural pneumonolysis. In the Jacobaeus operation, two cannulae are introduced into the pleural cavity through suitable intercostal spaces. The adhesion to be freed is visualized by means of a thoracoscope passed through one cannula, and division of the adhesion is effected by a galvano-cautery passed through the other. In 1915 Jacobaeus\textsuperscript{16} published a report of his first series of patients submitted to this operation. In 1922 Unverricht published a paper on thoracoscopy; writing in 1937, Alexander\textsuperscript{3} was of the opinion that Unverricht had had a wider experience of this operation than anybody. In 1934 Moore\textsuperscript{20} published a series of 2,043 cases collected from the reports of 41 surgeons. Among those who have reported series of cases since 1934 are Chandler\textsuperscript{7,8} (1937), Anderson and Alexander\textsuperscript{1} (1937), Brock\textsuperscript{5} (1938), Drash\textsuperscript{10} (1938), Edwards and Lynn\textsuperscript{11} (1939), Newton\textsuperscript{21} (1940), Thompson and Greenberg\textsuperscript{23} (1941), Carp and Kornblith\textsuperscript{4} (1942), and Goorwitch\textsuperscript{15} (1943), who reported the results of 413 operations performed by four surgeons on 365 patients. In 1944 Goorwitch\textsuperscript{15} published the results of pneumonolysis in 5,114 patients collected from series reported in the literature since the publication of Moore's collected series.

**STRUCTURE OF ADHESIONS**

As seen through the thoracoscope, adhesions display a wide variety of forms, ranging from thin cords and narrow bands to wide, thick membranes of a complexity almost impossible to describe, and to areas where the lung is densely adherent to the chest wall over a wide extent.

Brock\textsuperscript{5} has discussed the formation of adhesions. Normally, external to the parietal pleura is a thin layer of loose areolar tissue containing a few tiny blood vessels and nerves. As a result of chronic inflammation involving the pleura and extrapleural tissues, this layer becomes thickened and well defined. On the degree to which this layer and the parietal pleura retain their capacity to stretch depends the structure of adhesions as found in artificial pneumothorax. In early disease involving the pleura, before the development of fibrous tissue, upon the induction of pneumothorax these layers stretch and form the greater part of the adhesion. It is in this type of case that are seen the simpler bands and cords. As the inflammatory process becomes more chronic in character, with resulting formation of fibrous tissue, the capacity to stretch of the parietal pleura and extrapleural tissues becomes less, until finally the two layers of the pleura, together with the extrapleural tissues, become welded into a
dense layer in which no capacity to stretch remains. In such a
case, when pneumothorax is induced the portion of the lung
subjacent to the affected area remains firmly attached to the
ribs and intercostal muscles. Between the early case, in which the
parietal pleura and extrapleural tissues retain their full capacity
to stretch, and the long-standing case, in which this is entirely
lost, every intermediate stage is found. Several stages may be
found in the one adhesion. Examination of the parietal attach-
ment of an adhesion may reveal a central portion where the lung
is densely adherent to the parietes; immediately adjacent to this
the parietal pleura and extrapleural tissues may have stretched
to a limited degree, while the free edge of the adhesion may be
formed of stretched parietal pleura and extrapleural tissues, in
which no lung tissue is present.

It will be seen that many "adhesions," as seen in skiagrams in
cases of artificial pneumothorax, are in reality portions of lung
attached firmly to the chest wall. A type of "adhesion" seen fairly
commonly is that in which a portion of lung, perhaps containing
a cavity, is drawn out into the shape of a cone, tapering to a
narrow attachment to the chest wall; in this type a prolongation
of a cavity may extend almost to the chest wall. In some cases a
portion of lung is drawn out to form a tongue-shaped mass, which
is attached to the chest wall along a margin which may be several
inches in extent. From the mode of formation of pleural adhesions
it can be appreciated that, except in the case of thin bands, cords
and membranes, which can be satisfactorily transilluminated, the
danger of cutting into lung tissue during the freeing of adhesions
must constantly be guarded against. Except in the case of the
simple adhesions just mentioned, enucleation of the adhesions
from the chest wall should be performed, the line of separation
being external to the parietal pleura. The term "cutting" adhesions
conveys a wrong impression of the technique which should in
most cases be followed. I prefer to use the term "free" or "release"
rather than "cut."

TECHNIQUE

The original two-cannula technique, introduced by Jacobaeus,
in which the galvano-cauter is employed, is probably still that
most widely practised. However, during recent years there has
been a number of advocates for the use of the high-frequency
current, or electrosurgery, as it is usually termed by American
writers. Advantages claimed for electrosurgery are as follows:

1. The amount of tissue destruction on either side of the point
division of the adhesion is less than when the galvano-cauter
is employed; when the latter technique is used it is held that
because of the greater tissue destruction there is the possibility of bleeding from vessels incompletely coagulated, and, later, of the separation of areas of necrosis, which have not become organized, with consequent risk of spontaneous pneumothorax.

2. When electrosurgery is used, less heat is produced within the pleural cavity.

3. The duration of the operation is shortened by electrosurgery.

4. No smoke is produced when electrosurgery is used.

Matson, who used the galvano-cautyer in his earlier cases, later abandoned it in favor of electrosurgery and attributed the greater freedom from complications in his later cases to this change. Electrosurgery was used by Chandler, and is used by Moore, Drash, Newton, Cutler and others.

Supporters of the galvano-cautyer emphasize the following points: 1) the simplicity and relative cheapness of the equipment; 2) the greater difficulty of perfecting the operative technique when electrosurgery is used; 3) the liability to muscular spasms when electrosurgery is used, particularly in the case of adhesions situated at the extreme apex. Advocates of the galvano-cautyer include Brock and Alexander, both surgeons having had experience of electrosurgery. Alexander² notes that Jacobaeus and Unverricht, both of whom used the galvano-cautyer in their earlier cases, for a time employed electrosurgery but reverted to the use of the galvano-cautyer.

I have used the galvano-cautyer in 251 operations at which some degree of pneumonolysis was performed; in no case did there occur hemorrhage which could be attributed to the cause suggested above. In one or two of my cases it is possible that separation of an incompletely organized area of necrosis was a factor in the occurrence of spontaneous pneumothorax; nevertheless if there is a proper understanding of the technique of employing the galvano-cautyer in freeing pleural adhesions, the incidence of hemorrhage and spontaneous pneumothorax should, I believe, be no greater with this method than when electrosurgery is used. More heat may be produced within the pleural cavity when the galvano-cautyer is used, but I have seen no complication which I can attribute to this cause. Smoke sometimes occurs when the galvano-cautyer is used, but, although occasionally a mild annoyance, has not in my experience occasioned any real difficulty.

A single cannula technique has been used by some surgeons. Electrosurgery is used, and both thoracoscope and high-frequency electrodes are introduced through a single cannula. This technique was used by Chandler and has been used in America by O'Brien, Cutler and others. In my view the ability to introduce the telescope
through a separate cannula confers on the surgeon advantages which enormously outweigh the disadvantage, which indeed is minor only, of making two punctures instead of one. The field of vision is greater, and during the operation the telescope may be moved at will without altering the position of the cutting point of the cautery; because of this facility the adhesion which is being freed may be viewed from a different angle, or perhaps a vital structure such as the subclavian artery, lying immediately outside the field of vision, may be re-examined and its position in relation to the adhesion reassessed. A very important advantage of employing separate cannulae for the introduction of the telescope and the cautery is that the surgeon is able to transpose the instruments at any stage during the operation, introducing the telescope through the cannula originally used for the cautery and vice versa. Frequently by changing the positions of the instruments in this manner a better approach is obtained for the completion of the operation. Also, at the commencement of an operation it is my routine procedure to inspect the pleural cavity with the telescope introduced through each cannula in turn. I have found that the added information given by examining the pleural cavity from the second position has been very valuable indeed in assessing the adhesions to be freed. I feel that the inability to do this may deprive the surgeon of information necessary for a complete assessment to be made. It is my opinion that by the employment of the two-cannulae technique adhesions may be freed which it would not be possible to attempt working through a single cannula.

A further point with regard to the use of a single cannula is that, of necessity, the latter must be of large calibre; this may be a cause of difficulty in the case of patients possessing narrow intercostal spaces.

All-important in the operation of pneumonolysis is the question of illumination. It cannot be stressed too greatly that unless the illumination is adequate even an operation which would normally present little difficulty may be rendered dangerous. Various types of telescope have been used. I have found a telescope employing right-angled vision satisfactory for the majority of adhesions; however, in the case of some adhesions situated in the extreme apex of the thoracic vault it is very difficult to manipulate the telescope so that the mirror of the instrument is sufficiently close to the parietal attachment to obtain adequate illumination. For adhesions of this type a telescope employing a more direct type of vision such as the "Forobloque"* type is much more readily manipulated into position.

*Made by the American Cystoscope Manufacturers, Inc.
As regards the operation itself there are several points that may be stressed. The first essential is that the adhesion to be freed must be thoroughly examined, its limits defined, and its relation to vital structures determined; the limits of lung tissue in relation to the adhesion must be decided beyond doubt. The next point is the heat of the cautery tip. This should never be greater than that which will produce a dull red glow. When the cautery is too hot tissue is seared through, blood vessels are not coagulated, and hemorrhage is likely to occur. During the actual cauterization the tip of the cautery must always be in full view of the surgeon; failure to observe this rule may result in haemorrhage difficult to control, because the bleeding point is not clearly seen. Blunt dissection may frequently be employed; with the current off, the cautery tip is used as a dissector, the plane of dissection being external to the parietal pleura. Finally it must be stressed that closed intrapleural pneumonolysis is an operation in which meticulous care must be exercised from the commencement of the operation to the end: relaxation of vigilance for even a few seconds may easily result in irremediable disaster.

Anaesthesis: In my series, local anaesthesia has been used except in the case of two patients. Preliminary premedication is employed, and after several methods had been tried the most satisfactory was considered to be a combination of “Nembutal” and “Omnopon.” “Nembutal” (three grains) is given two hours before operation and “Omnopon” (two-thirds of a grain) one hour before. Anaesthesia is effected by infiltration of the tissues, through which the trocar is to be introduced. “Planoanaline” (0.5 per cent), to which are added three minims of adrenaline solution for each ounce of anaesthetic solution, is used. Frequently four ounces, and on occasion six ounces, of this solution have been used for a single patient. No untoward effects have been observed. The average amount required for each patient is about three ounces of solution. When necessary the parietal insertion of the adhesion itself may be infiltrated by means of a long needle introduced through one cannula. In the great majority of patients infiltration of the adhesion is unnecessary, and I prefer to avoid it. The needle may puncture a small vessel and troublesome oozing may follow; in addition, when the parietal end of the adhesion is infiltrated with anaesthetic solution I have found that cauterization is rendered appreciably more difficult.

In the case of one patient, who begged to be rendered unconscious, “Avertin” was used but was not satisfactory, because, although unconscious, she became restless as soon as the parietal pleura was touched with the cautery. In this case the operation had to be abandoned.
In the case of another patient, a rather nervous girl aged fifteen years, gas and oxygen anaesthesia was employed. This operation was completed satisfactorily, but was rendered difficult because of the large respiratory excursions.

Site of Punctures: Various sites have been recommended as the most suitable for introduction of the cannulae. Alexander recommends that, as the majority of adhesions are in the postero-lateral portion of the chest, the thoroscope should be introduced through the anterior or antero-lateral thoracic wall and the cautery through the mid-axillary or postero-lateral thoracic wall. Brock, on the other hand, states that he has never to his memory used an anterior puncture, and he finds the thought distasteful. Brock introduces the thoroscope posterior to the angle of the scapula in the sixth or seventh intercostal space. Alexander, again, states that on the few occasions on which he has chosen the posterior position as used by Brock it has given a relatively unsatisfactory view of postero-lateral adhesions, and that the narrowness of the posterior intercostal spaces has interfered with free and painless movement of the instrument.

I have tried a variety of puncture sites. Although formerly have expressed the view that the anterior and posterior axillary lines are the most suitable, I am now of the opinion that the sites recommended by Brock are to be preferred for most patients. I now always make the first puncture in the mid-axillary region and inspect the pleural cavity from this position. With the telescope still in position, I introduce the anaesthetic needle through the site projected for the introduction of the second cannula; I then visualize the point of the needle and assess the suitability of the site, and if for any reason it is considered unsatisfactory, another position is then readily chosen. Not very infrequently when there are present adhesions between the lung and the posterior region of the thoracic wall a trocar introduced posterior to the angle of the scapula will strike such an adhesion, and may even puncture the lung itself; for this reason usually it is not advisable to make the first puncture in this area. Although it is possible to strike an adhesion when introducing the trocar through the mid-axillary region, in my experience the likelihood of doing so is very much less in this area than it is in the posterior region of the thorax. With the patient lying on the side, in the usual position for operation with the side to be operated upon uppermost, there is a greater distance between lung and chest wall in the mid-axillary region than there is posteriorly; consequently the risk of puncturing the lung is much less in the mid-axillary region than it is posteriorly. Apart from the possibility just discussed of striking an adhesion when introducing the trocar pos-
terior to the angle of the scapula, in the case of an adhesion situated posteriorly in the extreme apex of the pleural cavity, I have occasionally found this site unsuitable because of the difficulty of tilting the cannula introduced through it to a sufficiently acute angle to enable the instrument passing through it to be brought into a suitable position in relation to the parietal end of the adhesion. In such a case the second cannula must be introduced through the posterolateral region of the thorax.

A manoeuvre which I have frequently employed with success, particularly in the case of an adhesion situated dangerously close to vital structure such as the subclavian artery, is the introduction of a third cannula. Through this cannula is passed a retractor. The retractor is placed in position so that the adhesion is lifted away from the vessel, or in some cases so that the lung is retracted to give a better approach to the adhesion. The assistant then takes the retractor. The disadvantage of this manoeuvre is the number of instruments crowded together in a relatively restricted area; in addition the assistant must hold the retractor blindly, being unable to see what she is doing. Nevertheless by employing a third cannula I have, in an appreciable number of patients, been enabled to complete the freeing of adhesions which otherwise I could not have attempted.

I do not think that painstaking attempts to map out the adhesions prior to operation, with the object of planning precise puncture sites accordingly, are repaid. Frequently the adhesions prove, on thoracoscopic examination, to be very different from the preoperative conception, and often adhesions unsuspected prior to operation are found.

**INDICATIONS FOR OPERATION**

Although occasionally one sees patients in whom artificial pneumothorax, prevented by adhesions from effecting complete relaxation of the lung, is followed by closure of cavities, and even by healing of the lesion in the great majority of such cases, the disease remains uncontrolled. Cavities not infrequently become smaller in the presence of incomplete pneumothorax, but rarely do they close completely, and so long as a residual cavity persists, there remains to the patient the potential danger of bronchogenic spread of the disease. Rich,²² in discussing the bronchogenic spread of tuberculosis, wrote as follows:

The site of origin is ordinarily a cavity, and it may even be quite a small one. It is not infrequently necessary to search the lungs carefully, by making thin sections with a sharp knife, in order to find a small cavity, that may be only half a centimetre in diameter, from which the bacilli responsible for small foci of tuberculous pneumonia in other portions of the lung were discharged.
Whilst all pleural adhesions do not necessarily prevent effective collapse, particularly in the case of basal adhesions, nevertheless any adhesions over the site of a lesion must be prejudicial to healing. Even when no cavity is obvious the continual tugging with each respiration over an area of active exudation is likely to prevent healing and even to cause spread of the process.

Brock, writing in 1938, made the following statement:

Most experienced workers now agree that even though cavities do not appear to be present in the lung that is held by adhesions, and although symptoms are absent or minimal, it is not safe to leave such a lung incompletely collapsed, if study of the earlier films shows that the adhesions are controlling areas of what was active disease.

A further aspect of the incomplete pneumothorax is the question of complications. There is general agreement that the more serious complications of artificial pneumothorax therapy, namely spontaneous pneumomothorax, persistent effusion, empyema and obliterate pleuritis, are much more common in those patients in whom the pneumothorax is complicated by adhesions than when a technically satisfactory collapse is present.

I have been interested to compare the results in my earlier cases of artificial pneumothorax with those in the more recent group, in which practically all patients with adhesions have been given the opportunity of having thoracoscopic examination, and when possible, pneumonolysis. Both from the point of view of absence of complications and from that of control of the pulmonary lesion, the results in the latter group are much the better; this, of course, has been noted by numerous observers in Europe and America. However, it strengthens me in the view that rarely should thoracoscopy be withheld from the patient in whose case an artificial pneumothorax, worth continuing at all, is rendered ineffective by adhesions.

SUITABILITY FOR OPERATION

Alexander gives as his experience that relatively few patients having artificial pneumothorax therapy have adhesions suitable for pneumonolysis, and he holds the view that less than 25 per cent of patients having this form of collapse therapy should be submitted to operation. Edwards and Lynn are of the opinion that with the aid of pneumonolysis complete collapse can be obtained in over 30 per cent of all cases of artificial pneumothorax. I believe that Alexander is unduly conservative in his view that less than 25 per cent of patients having artificial pneumothorax therapy are suitable for pneumonolysis.

The decision regarding suitability of any individual patient for
operation rests primarily on the skiagram. In a few cases the film indicates extensive pleural symphysis, which would obviously render impossible any attempt at pneumonolysis. In a few patients also the presence of simple cords and bands may be deduced with reasonable certainty. In the great majority of patients the nature and extent of adhesions cannot be determined from the skiagram alone, although usually it is possible to form a reasonably accurate estimate of their general complexity and to reach a conclusion as to whether operation is likely to be difficult. In my experience, in the case of patients about whom prior to operation I have formed the opinion that it was unlikely that pneumonolysis could be carried out, I have seldom been mistaken; on the other hand I have not infrequently found that in the case of patients in whom I had hoped to perform a complete operation, either pneumonolysis could not be done or could be performed only in part.

Fluoroscopic examination is a valuable aid in the assessment of adhesions, and in the case of a few patients oblique films have helped me considerably.

Some authors believe that considerable value attaches to stereoscopic films. Newton expressed the view that stereoscopic films are obligatory, but later admits that too much dependence cannot be placed on them and that the final decision as to operability can be made only after thorascopic examination. Brock has used stereoscopic films rarely, and “only when they have been supplied.” Alexander, although advising stereoscopic films, believes that the final decision regarding operation rests on the result of the fluoroscopic examination. With the view that in the great majority of cases the decision to undertake pneumonolysis can be made only after visualization of the adhesions through the thorascoscope I am in agreement.

At operation it is not infrequently found that what may appear on the skiagram as a simple cord is the edge of a broad membrane. Three cords as seen on the skiagram may prove to be the three edges of an adhesion which is T-shaped on cross section. An otherwise simple adhesion may be found at operation to be attached to a vital structure, as a consequence of which operation is rendered impossible. In my series, in an appreciable number of patients having adhesions attached to the extreme apex of the thoracic vault the parietal attachment of the adhesion has been either in close proximity to or directly over the subclavian artery. By using a third cannula as described above, I have been able to free a proportion of these adhesions, but there have remained a number of patients in whom I have considered that any attempt at pneumonolysis would have been far too hazardous. Frequently adhesions are found whose presence was not suspected prior to
operation. One type of adhesion which should be left untouched when found is the broad membrane holding up a large peripheral cavity. In this type of adhesion the peripheral wall of the cavity probably receives the greater portion of its blood supply through the adhesion. To sever the adhesion is likely to lead to sloughing of the cavity wall, with consequent development of spontaneous pneumothorax.

The decision whether to operate in patients in whom extensive adhesions are present sometimes requires the exercise of considerable judgment. A situation not uncommonly met is where the apex of the lung is held up by an extensive adhesion, frequently highly complex in form and arrangement. Examination of such an adhesion may reveal that it would be possible to free the adhesion in a large part of its extent, but that complete freeing could not for technical reasons be achieved. I have carried out partial pneumonolysis in a number of such cases, and have in some of them obtained an excellent result. Nevertheless, I am somewhat averse to undertaking partial pneumonolysis of this type. I feel that there is the risk that the unfreed portion of the adhesion may tear further, with the possibility that spontaneous pneumothorax may result, particularly in the case of apical adhesions situated posteriorly, I do not like leaving an adhesion partly freed; in several cases in which I have done this with the intention of completing pneumonolysis at a further session, at the subsequent operation the lung has been found to have become densely adherent to the chest wall, precluding any further attempt at freeing the lung.

Assessment of adhesions through the thoroscope may reveal that there is a number of simple adhesions which could readily be freed, but that the main adhesion present could not be freed. Freeing of adhesions which cannot result in any benefit to the patient is merely meddlesome, and is to be strongly deprecated.

**DURATION OF PNEUMOTHORAX BEFORE OPERATION**

It has been advised in the past that a sufficient period should be allowed for the adhesions to stretch before pneumonolysis is attempted. Alexander has stated that pneumonolysis should not be undertaken in the average patient until three to six months after the induction of pneumothorax. However, it is to be remembered that with the passage of time fibrous tissue formation takes place in the adhesion, which becomes shorter, tougher and broader; as a consequence of this, operation is rendered more difficult. Further, if pneumonolysis is delayed for several months there is the risk that complications such as spontaneous pneumothorax may occur during the period of waiting. The attempt to
stretch adhesions by the use of positive pressure is highly dangerous, and cannot be condemned too strongly; tearing of the adhesion at the visceral end may occur, with consequent development of spontaneous pneumothorax. Finally, if operation is deferred unnecessarily, time is being wasted, since in the estimation of the period in which pneumothorax should be continued in any patient the date at which the pneumothorax is rendered effective must be considered as the date of commencement.

Newton\textsuperscript{21} advises operation as soon as the maximum collapse obtainable without the use of high pressures has been reached, provided that a sufficient space exists and the adhesions seem operable. Thompson and Greenberg advocate operation about three weeks after induction of pneumothorax. My own view is that operation should be undertaken as soon as an adequate space is present in which to work. In one patient I performed satisfactory pneumonolysis thirteen days following induction of pneumothorax; I have frequently operated fourteen days following induction of pneumothorax, and in the majority of patients there is little reason to delay operation beyond this period. In the case of patients with the more complex type of adhesions a rather longer waiting period is sometimes necessary to gain an adequate space in which to work, but as stressed above, forcing by positive pressure should never be resorted to.

\textbf{THE PRESENT SERIES}

\textit{Clinical Material}

The clinical material on which this study is based is set out in the following scheme:

<table>
<thead>
<tr>
<th>Total number of thoracoscopic examinations (including more than one operation on the same patient and operations at which thoracoscopic examination only was performed)</th>
<th>311</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of individual pleural cavities inspected</td>
<td>288</td>
</tr>
<tr>
<td>Number of patients to have both pleural cavities inspected</td>
<td>17</td>
</tr>
<tr>
<td>Number of persons to have thoracoscopic examination of one or both pleural cavities</td>
<td>251</td>
</tr>
<tr>
<td>Number of lungs upon which pneumonolysis, complete or incomplete, was performed</td>
<td>225</td>
</tr>
<tr>
<td>Number of patients to have pneumonolysis performed on both lungs</td>
<td>15</td>
</tr>
<tr>
<td>Number of persons to have pneumonolysis performed on one or both lungs</td>
<td>210</td>
</tr>
<tr>
<td>Total number of operations at which some stage of pneumonolysis was carried out</td>
<td>251</td>
</tr>
</tbody>
</table>

In the case of one pleural cavity four thoracoscopic examinations were carried out.
In the case of four pleural cavities three thoracoscopic examinations were carried out.

In the case of 32 pleural cavities two thoracoscopic examinations were carried out.

In the case of 231 pleural cavities one thoracoscopic examination was carried out.

Complete pneumonolysis was performed in the case of 123 lungs. Incomplete pneumonolysis was performed in the case of 102 lungs. Pneumonolysis was not attempted in the case of 43 lungs. By complete pneumonolysis is meant that all adhesions preventing effective collapse of the lung were freed. By incomplete pneumonolysis is meant that in the case of multiple adhesions some, but not all, of the restraining adhesions were freed, or in the case of a single large adhesion, that a significant portion was freed.

The results in the first 115 patients in whom thoracoscopic examination was carried out have already been published. Of the 311 operations, 229 were performed at the Canterbury District Hospital and 82 at the Royal North Shore Hospital.

In Table I are shown figures which indicate, in the case of a few representative published series, the proportion of patients submitted to thoracoscopic examination in whom pneumonolysis, complete or incomplete, was carried out.

<table>
<thead>
<tr>
<th>Author</th>
<th>Total Number of Patients</th>
<th>Complete Pneumonolysis</th>
<th>Incomplete Pneumonolysis</th>
<th>Pneumonolysis Not Attempted</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anderson and Alexander</td>
<td>111</td>
<td>41 (37.0)</td>
<td>46 (41.4)</td>
<td>24 (21.6)</td>
</tr>
<tr>
<td>Edwards and Lynn</td>
<td>255</td>
<td>86 (34.0)</td>
<td>140 (55.0)</td>
<td>29 (11.0)</td>
</tr>
<tr>
<td>Carp and Kornblith</td>
<td>100</td>
<td>32 (32.0)</td>
<td>43 (43.0)</td>
<td>25 (25.0)</td>
</tr>
<tr>
<td>Matson</td>
<td>249</td>
<td>154 (61.9)</td>
<td>19 (7.6)</td>
<td>76* (30.5)</td>
</tr>
<tr>
<td>Brock</td>
<td>361</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>

*With regard to these 76 patients reported in Matson's paper, the following comment is made by the author: "This group comprised cases unsuitable for operation. In most cases minor adhesions of no technical importance were severed."

Goorwitch found that of the 5,114 patients in his collected series who had pneumonolysis performed, in 52 per cent the operation was complete and in 48 per cent it was incomplete.

Of the 102 lungs upon which incomplete pneumonolysis was carried out, satisfactory relaxation followed in 44 cases. This result indicates the importance of freeing all adhesions preventing relaxation of the lung whenever possible; on the other hand, that
of 102 cases in which incomplete pneumonolysis was carried out satisfactory relaxation of the lung followed in 44 shows that the incomplete operation may not infrequently result in a satisfactory pneumothorax being obtained.

TYPE OF ADHESIONS

The patients in my series are not a selected group, and include a large number who have had advanced disease. The largest single group in the series comprises patients referred from a sanatorium to which patients with early disease ordinarily are not sent. Indeed in studying the history and original skiagrams of patients upon whom I have performed thoracoscopy I have been impressed by the late stage at which so many have come under treatment. In the majority of patients this has seemed to be because of the late stage at which patients themselves have felt the need to seek medical advice. It seems that if patients are to come under treatment when the disease is at an early stage a State-wide scheme involving the use of photofluorography will be necessary. Several of the patients in my series came under treatment following investigations consequent on the finding of suspicious signs on routine photofluorographic examination of the chest at the time of enlistment in one or other of the services; a few women are included in this group.

I have arbitrarily divided the adhesions seen into four grades, according to their number and complexity, as follows: grade I, not extensive (for example, one or two simple cords or narrow bands, or one rather wider band); grade II, moderately extensive (for example, two or three bands about one inch wide, or one fairly wide band; in one of my cases there were present one thick adhesion about one and a half to two inches wide, one narrow band and one short membrane about one inch wide); grade III, extensive (for example, in one of my cases, ten bands of varying widths, thicknesses and lengths were present); grade IV, very extensive (in most of these patients pleural symphysis was present over wide areas, and in most pneumonolysis was not attempted, although in a few cases partial freeing of the lung was possible.

In accordance with this classification, in 32 cases adhesions classed as grade I were present; in 65 cases adhesions classed as grade II were present; in 110 cases adhesions classed as grade III were present; and in 58 cases adhesions classed as grade IV were present. In the case of three patients in whom the presence of adhesions was suggested by the appearance of the lung contours on the skiagram, no adhesions were found on thoracoscopic examination.
CONTRALATERAL DISEASE

Of the 251 patients upon whom thoracoscopic examination was carried out, bilateral disease was present in 143 cases. Pneumolysis was carried out on 225 lungs; in 32 cases contralateral pneumothorax was being maintained at the time of operation. In addition, contralateral artificial pneumothorax was being maintained in the case of four patients in whom thoracoscopic examination only was carried out.

DURATION OF PNEUMOTHORAX PRIOR TO OPERATION

The shortest period from the time of induction of pneumothorax to the time of operation was thirteen days, and the longest three years. In 110 cases pneumothorax had been present for less than three months, in 83 cases from three to six months, in 60 cases from six to twelve months, in 11 cases from twelve to eighteen months, in one case from eighteen to twenty-four months, and in three cases over two years.

AGE OF PATIENTS

The youngest patient in the series was fifteen years old and the oldest was aged forty-eight years. Chandler,7 in his series, records that he operated upon a child aged seven years; the same author notes that he also operated upon a patient aged fifty-four years.

FINAL ASSESSMENT

Goorwitch,15 in discussing the results of pneumolysis, expresses the view that any beneficial results occurring in patients who have had pneumolysis performed must be attributed to the artificial pneumothorax, which is merely rendered more effective by the operation. This is, of course, true; nevertheless I believe that it is not unprofitable to attempt to determine those patients in whom, without operation, pneumothorax would not have succeeded in controlling the diseased process but in whom, following pneumolysis, a more effective collapse has been enabled to do so. The criteria of a successful operation are the subsequent closure of cavities, the inability to recover tubercle bacilli from the patient by modern methods of investigation, such as culture of the fasting gastric contents, and the absence of complications which have caused any permanent detriment to the patient. In any given patient, to decide whether artificial pneumothorax, which has been successful following pneumolysis, would not have been successful if no operation had been performed is often very difficult, and maybe impossible. Nevertheless for an observer experienced in artificial pneumothorax therapy, I believe that in
the majority of cases it is possible to reach a conclusion. Consequently, in respect of this series, the attempt has been made to divide the results into successful and unsuccessful, in accordance with the ultimate benefit to the patient. In some cases, although complete relaxation of the lung was obtained cavities have not closed; in these cases, although technically the operation was a success, it was a failure from the point of view of the patient. In a few patients in whom complete relaxation of the lung was obtained serious complications have occurred. There have also been some patients in whom pneumonolysis appears to have been followed by control of the disease in the lung operated upon, but whose ultimate fate will depend on measures directed to the other lung in which uncontrolled disease is present. It seems not unreasonable to assess the result of operation in these patients as provisionally successful. Also, in the case of a few of the patients who have had bilateral pneumonolysis performed, while the operation on one lung appears to have been followed by control of the lesion in that lung, as regards the other lung the result is still in doubt or has been unsuccessful. The result of operation in the case of each lung in those patients who have been submitted to bilateral operation will be indicated.

Two hundred and ten persons had pneumonolysis performed, 15 of these having had both lungs operated upon. In the case of 111 of these patients control of the disease appears to have occurred or seems likely to occur; in the case of 13 patients the operation has been classed as provisionally successful; in the case of 57 patients the operation has been unsuccessful, and in the case of 29 patients it is considered that too short a period has elapsed for a final conclusion to be drawn. Of this last group of 29 patients, which includes six in whom bilateral pneumonolysis has been carried out, an excellent final result is confidently hoped for in at least 10 cases, but I prefer not to include these among the "successes" at this stage.

Of the 15 patients in whom bilateral pneumonolysis has been carried out operation appears to have been followed by control of the lesion in both lungs in six cases; two patients are included in the group noted above, in whom a favourable outcome is confidently hoped for; in the case of three patients, while the disease in one lung appears to be under control the outcome in the case of the other lung is still in doubt and other measures may need to be instituted. In the case of two patients too short a period has elapsed for an opinion to be given. As regards the remaining two patients, although in one of them excellent relaxation of both lungs is present, it is considered that the ultimate outlook is unsatisfactory.
Of the total of 225 lungs upon which pneumonolysis was performed, operation appears to have resulted in a pneumothorax which was effective in controlling the lesion in the lung concerned in 130 cases.

Of the 5,114 cases in Goorwitch's collected series, 73 per cent were considered to be clinically successful.

COMPLICATIONS

Complications of pneumonolysis include hemorrhage, persistent nonpurulent effusion, spontaneous pneumothorax, bronchopleural fistula, empyema and contralateral spread of the disease. A late sequel may be obliterative pleuritis. Less important complications seen include transient serous effusions, surgical emphysema, postoperative vomiting, injury to nerves and dyspnea during operation. Pleuro-cutaneous fistula may occur as a complication of empyema, forming along the needle track following aspiration; a fistula also may be the result of empyema necessitatis.

Hemorrhage: Hemorrhage may occur from the site of separation of the adhesion, from injury to a major vessel such as the subclavian artery, or, rarely, from injury to an intercostal artery by the trocar.

In order to lessen the risk of injury to the lung, adhesions should be divided flush with the chest wall, or preferably in the majority of cases enucleated from the chest wall. This increases the risk of injuring an intercostal vessel or one of its branches. However, with adequate experience and careful attention to technique I am firmly of the opinion that hemorrhage from this source should rarely if ever occur. In my series there were three patients who suffered severe hemorrhage. These patients were operated upon at an early stage in my experience, and over 200 consecutive operations at which pneumonolysis was actually carried out have since been performed without the occurrence of any but minor hemorrhage, which has easily been controlled.

Hemorrhage has been reported to have occurred through opening into one of the great vessels. Alexander\(^2\) notes that Gullbring reported the death on the operating table of a patient whose subclavian artery had been opened into. Goorwitch\(^5\) states that he has personal knowledge of three instances of operative injury to the mediastinal vessels with a rapidly fatal outcome. Many adhesions are situated in the extreme apex of the thoracic cavity where the approach to the adhesion may be very difficult and where it is frequently necessary to apply the cautery in close proximity to the subclavian artery; however, careful appraisal of the adhesion to be freed and identification of the great vessels before commencing cauterization, and above all, unremitting care
during the operation should prevent the occurrence of this catastrophe.

Rarely, troublesome hemorrhage occurs as a result of the trocar puncture. In the case of one patient in my series steady, although not severe, hemorrhage was still present at the termination of an operation which had lasted about forty minutes. The hemorrhage appeared to come from just inside the internal opening of the puncture. It is possible that this hemorrhage would have stopped spontaneously; however, a third cannula was introduced and the cautery passed through it. The tip of the cautery was then carefully inserted into the bleeding opening and the area from which the hemorrhage appeared to be coming was coagulated. This manoeuvre was successful in stopping the hemorrhage. Goor-witch\textsuperscript{15} notes the occurrence in one of his own patients of hemorrhage the source of which he believes to have been an intercostal vein traumatized at operation by the trocar.

Blood vessels of any magnitude are seldom present in the adhesion itself. However, in one of my cases tortuous veins about one-eighth of an inch in diameter were present on the surface of a band about one inch wide. I was able to coagulate these veins and the adhesion was freed without incident. As regards the three patients mentioned above who suffered severe hemorrhage, death from blood loss did not occur in any case. One patient later developed tuberculous empyema, and this case will be fully considered in a later section. In the case of the two patients, both of whom had advanced bilateral disease, in spite of repeated aspiration the hemorrhage rapidly became loculated and later became organized, although empyema did not follow in either case. One of these two patients died two months following operation, the cause of death being the burden of an organized hemothorax added to extensive bilateral disease. The other patient lived for six months. This, in the opinion of his physician, was his expectation of life had no operation been performed.

Table II shows the incidence of hemorrhage in a number of reported series of patients. In the attempt to compare different series, not infrequently difficulty is experienced because various authors interpret incidents differently. For example, Matson,\textsuperscript{18} in one paper, refers to a hemorrhage involving the loss of two litres of blood as "moderate"; other authors might class a hemorrhage of this order as serious. Drash,\textsuperscript{19} in reporting three cases of hemorrhage in his series, noted one as "serious" and two as "moderate"; nevertheless in two of these cases open operation was necessary to control the bleeding.

At this stage, in order to avoid repetition, I will discuss the general question of recording complications. Some authors, for
example Edwards and Lynn,11 have shown complications as a percentage of all operations performed, irrespective of whether pneumonolysis was performed or not or whether the total includes more than one operation on the same patient. Calculated in this manner, complications in my series would be based on a total of 311 cases. Anderson and Alexander1 have shown complications as a percentage of the total number of patients upon whom thoracoscopic examination was carried out, inclusive of those patients in whom pneumonolysis was not done. For my series, counting each pleural cavity inspected as an individual (vide infra), the corresponding basis of calculation would be 268. Again, others, such as Brock,5 take the total number of operations at which any degree of pneumonolysis was performed. The corresponding figure in my series would be 251. Obviously such variable methods of indicating results leads to hopeless confusion when comparing the records of various authors, and some uniform basis of comparison must be decided upon.

It is true that every operation carries its own risk of complications, but as regards thoracoscopic examination in patients in whom pneumonolysis is not done I feel that the risk of subsequent

<table>
<thead>
<tr>
<th>Author</th>
<th>Number of Operations</th>
<th>No. of Cases of Severe Hemorrhage</th>
<th>No. of Cases of Small Hemorrhage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anderson and Alexander</td>
<td>87</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Brock</td>
<td>360</td>
<td>3 (0.8)</td>
<td></td>
</tr>
<tr>
<td>Carp and Kornblith</td>
<td>75</td>
<td>2 (2.6)</td>
<td></td>
</tr>
<tr>
<td>Drash</td>
<td>251</td>
<td>1</td>
<td>2 (&quot;moderate&quot;)</td>
</tr>
<tr>
<td>Edwards and Lynn</td>
<td>231</td>
<td>1 (0.4)</td>
<td>6 (2.6)</td>
</tr>
<tr>
<td>Goorwitch (four surgeons)</td>
<td>413</td>
<td>12 (2.8)</td>
<td>24 (5.8)</td>
</tr>
<tr>
<td>Goorwitch (collected series)</td>
<td>5,888</td>
<td>1 (1,000 cc. or more)</td>
<td>3 (3.3)</td>
</tr>
<tr>
<td>Jacobaeus</td>
<td>600-700</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Matson</td>
<td>249*</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Moore (38 surgeons)</td>
<td>2,043</td>
<td>15 (0.7)</td>
<td>16 (0.8)</td>
</tr>
<tr>
<td>Newton</td>
<td>182</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Unverricht</td>
<td>950</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Viswanathan</td>
<td>50</td>
<td>2 (4.0)</td>
<td></td>
</tr>
</tbody>
</table>

*See footnote to Table I.
complications attributable to the operation is so small that such complications should be shown separately from those following pneumonolysis. Again, in the case of those patients who have required more than one operation, my own feeling is that except in the case of hemorrhage complications should be estimated on the basis of the number of lungs operated upon rather than the number of operations. As regards hemorrhage, I believe it is reasonable to estimate the occurrence of hemorrhage as a percentage of the total number of operations at which pneumonolysis in any degree was carried out. In those patients in whom pneumonolysis has been performed on both lungs each lung of course presents an entirely individual problem from the point of view of complications.

To summarize my views, I believe that cases of hemorrhage should be shown relative to the total number of operations at which pneumonolysis was carried out, and that all other complications should be shown on the basis of the number of lungs upon which pneumonolysis has been carried out. As far as possible, I have endeavoured to follow this scheme in compiling the tables shown in this thesis.

In Goorwitch's collected series there are 5,114 patients, upon whom 5,886 operative stages were carried out. Except in the case of obliteratorive pleuritis and loss of pneumothorax space, Goorwitch has shown the incidence of complications as a percentage of the number of operative stages. Where necessary, I have modified his figures so that they are shown as percentages of the number of patients. In studying Goorwitch's statistics one is struck by the number of authors quoted in his series who have failed to record relevant data; for example, with regard to such an important complication as tuberculous empyema Goorwitch was able to collect information in the case of two-thirds of the total number of patients only, while as regards obliteratorive pleuritis the incidence was recorded in one-quarter of the total number of patients. I have experienced similar difficulties in studying the records of some authors.

Pleural Effusion: Alexander is of the opinion that a small amount of serous exudate confined to the costo-phrenic sinus probably occurs in the majority of patients. Brock states that a slight amount of fluid after operation is inevitable, owing to the trauma inflicted and to oozing from the site of puncture. Smoke has been cited as a cause of serous effusion when the galvanocautery is used. Smoke has, however, rarely been of consequence in my cases, and I believe that it is unlikely to be a causative factor in fluid formation. Fluid of the type mentioned is absorbed within a week or so, and is of no importance.
Of the 268 pleural cavities inspected, fluid in sufficient amount to be visible on the skiagram was present in 22 cases prior to operation. In two of the patients in this group a persistent non-purulent effusion developed. In one patient there occurred an effusion, moderate in amount, which was absorbed in the course of two or three weeks. In two patients empyema occurred. In the case of one patient in whom a considerable amount of fluid was present prior to operation, the effusion persisted at about the same level, and about seven months later obliterator pleuritis became evident. In the case of these six patients pneumonolysis was performed. No complication occurred in the remaining sixteen patients, in whom the fluid present prior to operation was absorbed subsequently.

In the case of two patients not included in the last group empyema was found at thoracoscopic examination; in neither of these patients was pneumonolysis attempted. In the case of 17 patients in whom fluid could not be detected on the skiagram prior to operation, non-purulent fluid classed as "much" or "persistent" developed subsequent to operation. By "much" is meant an amount sufficient, with the patient in the erect position, to show on the skiagram a "fluid level" higher than the dome of the diaphragm. By "persistent" is meant fluid which persisted for a period longer than four weeks. In at least two patients included in this group the fluid was not very great in amount and it was absorbed within two or three weeks; since the fluid seemed to be the result of a pleural reaction not severe in degree, but definite, these cases are recorded in this group. One of the patients in whom a persistent effusion occurred had been submitted to thoracoscopic examination only; the remaining sixteen patients in whom there developed an effusion classed as "much" or "persistent" had pneumonolysis, complete or incomplete, performed. Consequently, of the 225 cases in which pneumonolysis was carried out a non-purulent pleural effusion classed as "much" or "persistent" followed in 20 cases (9 per cent); this number includes those cases in which fluid was noted in the pleural cavity before operation and in which, following operation, a pleural reaction occurred.

Of the 43 patients in whom thoracoscopic examination only was performed, a pleural effusion of the type under discussion followed in one case; it is of interest, and may be of significance, that pleural tubercles were seen in the case of this patient.

The importance of the occurrence of a pleural effusion of this type in my cases rests in the fact that of the 20 patients in this group, in no fewer than 12 obliterative pleuritis developed at some period subsequently.
In 14 patients, including the two mentioned above, in whom non-purulent fluid was noted prior to operation, empyema developed at some period subsequent to operation. These patients will be discussed fully in a later section.

There then remain 173 patients in whom no fluid was noted on the skiagram prior to operation and in whom, subsequent to operation, either fluid, in amount sufficient to be visible on the skiagram, did not occur or there occurred fluid, slight in amount, which was rapidly absorbed and was not of clinical significance. If to these 173 patients are added the 16 patients in whom fluid noted prior to operation either was absorbed completely subsequent to operation or else persisted for a few weeks in an amount just visible in the costo-phrenic sinus, it is seen that of 225 cases in which pneumonolysis was carried out in 189 no pleural reaction occurred; of the 43 cases in which thoracoscopic examination only was made, which include the two patients in whom empyema was found but in whom no further reaction followed operation, no pleural reaction resulted in 42 cases.

In Table III an attempt is made to compare the incidence of non-purulent effusion in a few recorded series. In compiling this table difficulty has been experienced in appreciating the significance to be attached to such terms as "very small," "moderate" et cetera, as used by different authors. In this table, "number of patients" refers to the number of lungs upon which pneumonolysis was performed.

**TABLE III**

<table>
<thead>
<tr>
<th>Author</th>
<th>Number of Patients</th>
<th>Number of Cases of Pleural Effusion</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Transient or Very Small</td>
</tr>
<tr>
<td></td>
<td>Per cent</td>
<td>Per cent</td>
</tr>
<tr>
<td>Brock</td>
<td>302</td>
<td>81 (26.8)</td>
</tr>
<tr>
<td>Chandler</td>
<td>157</td>
<td>8 (5.1)</td>
</tr>
<tr>
<td>Edwards and Lynn</td>
<td>226</td>
<td>20 (8.8)</td>
</tr>
<tr>
<td>Goorwitch (four surgeons)</td>
<td>375</td>
<td>48 (12.8)</td>
</tr>
<tr>
<td>Goorwitch (collected series)</td>
<td>5,114</td>
<td>(16.0)</td>
</tr>
<tr>
<td>Newton</td>
<td>148</td>
<td>18 (12.0)</td>
</tr>
</tbody>
</table>

*Empyema:* Emphyema following pneumonolysis may be tuberculous in origin, it may result from pyogenic infection, or mixed tuberculous and pyogenic infection may be present. Pyogenic infection, I believe, only rarely follows infection introduced into the pleural cavity at operation; when it occurs, pyogenic infection
of the pleural cavity is usually the result of spontaneous pneumothorax. Occasionally a tuberculous empyema which is being treated by repeated aspiration may become infected; with this possibility in mind it should be a sine qua non that all aspirations must be performed with the strictest aseptic technique. A purulent exudate may follow injury to the lung at operation, or a small area of necrosis which has failed to become organized may separate from the surface of the lung during the period immediately subsequent to operation. In one patient in whom spontaneous pneumothorax occurred three weeks following operation I believe that this was the mode of development. In some patients a persistently recurring serous effusion may gradually become purulent after many weeks.

Drash has discussed the development of empyema following pneumonolysis in a very valuable paper. He cites the work of Joannides, who was able to demonstrate the presence of very small tubercles on the surface of the pleura. These tubercles may very readily be dislodged—for example, by continually being washed by an effusion. Fibrin plaques on the pleural surface often contain tubercle bacilli. If such tubercles or plaques are present close to the insertion of an adhesion, it is not difficult to imagine that bacilli may be set free during the manipulations incident to the freeing of the adhesion. Again, tubercle bacilli may become sealed between the visceral and parietal pleura where the two layers have become fused at the site of chronic disease. If during the freeing of an adhesion this zone is opened into, bacilli may escape into the pleural cavity. It must again be stressed that in freeing an adhesion, except in the case of thin bands and cords which are formed of stretched parietal pleura and extrapleural tissues and which can be satisfactorily trans-illuminated, the plane of separation should be external to the parietal pleura. A further possible source from which bacilli may enter the pleural cavity is from lymphatics coursing through an adhesion. These lymphatics may contain tubercle bacilli. During the freeing of an adhesion these lymphatics may be torn or divided and the openings made not be sealed over; from these incompletely sealed channels bacilli may escape.

The presence of tubercles on the pleura when seen through the thoracoscope is an important danger signal to the surgeon, and considerable caution should be exercised before a decision is made to proceed with pneumonolysis in their presence. Unverricht is stated by Alexander to have found that there is great danger of tuberculous empyema resulting if pneumonolysis is carried out when tubercles are present, even at some distance from the divided adhesion. In Anderson and Alexander's series, tubercles were
present in "at least seven" of their 111 patients. In the case of
two patients only was pneumonolysis performed; in one of these
patients a tuberculous empyema occurred.

In the course of my inspection of 268 pleural cavities, pleural
tubercles were found in 14 cases. In six cases no attempt at
pneumonolysis was made. In one of these patients two weeks
following operation a pleural reaction occurred, accompanied by
an effusion which persisted for a number of weeks; this patient
has been mentioned above in the discussion on pleural effusion.
One patient had complete pneumonolysis performed by the freeing
of ten adhesions of various widths and lengths; recovery was
uneventful in this case. Seven patients each had a number of
adhesions freed. In the case of five of these patients convalescence
was uneventful. One of the other two patients, for whom six
adhesions of various types were freed, had a number of tubercles
arranged in the form of a rosette on the parietal pleura; in the
center of this rosette was attached a thin band about half an
inch wide, which was seen to pull on the parietal pleura with
every respiration. As the structure of this adhesion permitted of
its being divided some distance from the chest wall, it was con-
sidered that the risk of complications following division was
probably not as great as that associated with the constant tugging
on the parietal pleura if it were left untouched. The adhesion was
consequently divided. Two weeks following operation a serous
effusion occurred; this persisted for about six weeks before finally
being absorbed. In the case of the remaining patient tubercles
were noted at the base of two adhesions which were left un-
touched. Death, attributed to shock, occurred forty-eight hours
after operation; this patient will be fully discussed in the section
dealing with shock.

In my series empyema has occurred in 14 patients (6.2 per cent).
In the case of eight of these patients tubercle bacilli were re-
covered from the fluid. In the case of two patients no organism
was recovered from the fluid, and in these patients the empyema
has been presumed to be of tuberculous origin. In the case of
three patients both tubercle bacilli and pyogenic organisms were
found. In the case of the remaining patient the empyema was
pneumococcal in origin. Bacteriological examination of the fluid
has included examination by direct smear and attempted culture
both for tubercle bacilli and pyogenic organisms. The periods
following operation at which empyema has been noted have been
as follows: two weeks, three patients; three weeks, three patients;
four weeks, two patients; seven weeks, one patient; eight weeks,
three patients; sixteen weeks, two patients.

The status of the 14 patients who developed empyema is as
follows: three patients are dead, death having occurred ten months, thirteen months and ten months respectively following operation. In the case of one patient the empyema subsided spontaneously and pneumothorax is being continued. As regard to another case, in this patient also spontaneous recovery from the empyema seems likely to occur, and there appears also a reasonable prospect of the pulmonary condition becoming stabilized without further active measures. In the case of one patient, cure of the empyema followed treatment with penicillin and complete expansion of the lung occurred. Two patients have had thoracoplasty performed, and the result in both patients has been satisfactory from the point of view of obliteration of the pleural space and also as regards control of the pulmonary lesion. The prognosis of two patients appears to be hopeless; in neither case could major surgery be contemplated. As regards another case, on present indications the ultimate outlook for this patient also appears to be hopeless. In three cases, (one already mentioned), thoracoplasty will probably be necessary.

Of the 14 patients in whom empyema occurred in eight the empyema was preceeded by spontaneous pneumothorax.

In studying the patients in whom empyema occurred it is seen that, with one exception, all had extensive adhesions. Naturally the question arises as to the advisability of attempting pneumonolysis in patients in whom extensive adhesions are present. After close study I believe that with my present experience I would probably not have attempted pneumonolysis in the case of four of the patients in whom empyema occurred. I would still regard the remaining ten patients as suitable for pneumonolysis; a large number of patients in my series who have been operated upon without incident and in whom an excellent final result has followed have had adhesions of equal or greater complexity than were present in these ten patients. Pleural adhesions are so variable in arrangement and complexity that it is difficult to make fixed rules as regards suitability for operation. As mentioned above, I have become more and more averse to attempting pneumonolysis in cases in which it is necessary to leave an adhesion partly freed. This applies more particularly to the type of adhesion in which one free edge can be defined but in which the other border merges into an area where the lung is adherent to the parietes. This type of adhesion is not infrequently seen in the posterior apical region in cases in which the posterior surface of the apical and subapical portions of the lung is adherent to the chest wall. As regards those adhesions in which both borders can be clearly defined, provided that pneumonolysis is possible at all, I now rarely find more than one operative stage to be required
for complete freeing to be effected. This experience of course has no relation to the case, multiple adhesions being present, in which some adhesions are freed at one operation and the remainder left for a further stage.

In assessing the suitability of patients for pneumonolysis, my tendency has been to become more conservative.

The treatment of tuberculous empyema has always presented a problem of extreme difficulty. In the case of those patients who have still been under my care when the empyema was first noted, treatment has been by repeated aspiration. In one case recovery followed; it must be mentioned that in this case tubercle bacilli were never recovered from the pleural fluid, and the diagnosis of tuberculous empyema was presumptive only. In one other patient recovery seems likely to take place. In another case complete recovery from the empyema occurred as a result of treatment with penicillin, but in this case the empyema was not of tuberculous origin. The present position as regards the treatment of tuberculous empyema is that the great majority of patients suffering from this condition ultimately require thoracoplasty to close the pleural space.

<table>
<thead>
<tr>
<th>Author</th>
<th>No. of Patients</th>
<th>Tuberculous</th>
<th>Pyogenic and</th>
<th>Mixed Infection</th>
<th>Total Per cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anderson and Alexander</td>
<td>87</td>
<td>4</td>
<td>2</td>
<td>6 (7.2)</td>
<td></td>
</tr>
<tr>
<td>Brock</td>
<td>302</td>
<td>5</td>
<td>5</td>
<td>10 (3.3)</td>
<td></td>
</tr>
<tr>
<td>Chandler (1st series)</td>
<td>89</td>
<td>3</td>
<td>4</td>
<td>7 (7.8)</td>
<td></td>
</tr>
<tr>
<td>Chandler (2nd series)</td>
<td>68</td>
<td>1</td>
<td>0</td>
<td>1 (1.4)</td>
<td></td>
</tr>
<tr>
<td>Drash</td>
<td>230</td>
<td>6</td>
<td>0</td>
<td>6 (2.6)</td>
<td></td>
</tr>
<tr>
<td>Edwards and Lynn</td>
<td>226</td>
<td>32</td>
<td></td>
<td>32 (13.5)</td>
<td></td>
</tr>
<tr>
<td>Goorwitch (four surgeons)</td>
<td>373</td>
<td></td>
<td></td>
<td>31 (8.3)</td>
<td></td>
</tr>
<tr>
<td>Goorwitch (collected series)</td>
<td>5,114</td>
<td>(3.5)</td>
<td>(1.4)</td>
<td>(4.9)</td>
<td></td>
</tr>
<tr>
<td>Matson</td>
<td>249</td>
<td>41</td>
<td></td>
<td>41 (16.5)</td>
<td></td>
</tr>
<tr>
<td>Newton</td>
<td>148</td>
<td>3</td>
<td></td>
<td>3 (2.0)</td>
<td></td>
</tr>
</tbody>
</table>

Matson, in 1934,19 published an interesting discussion of his 249 cases. His first group included 136 cases in which the Jacobaeus technique, with the use of the galvano-cautery, was used; in the second group of 35 cases he used electrosurgery with what he describes as an obsolete high-frequency unit; in the final group of 78 cases he used electrosurgery with a Bovie high-frequency unit.
Matson attributes the progressive improvement in his results to the different methods used. However, it may perhaps not unreasonably be suggested that his greater experience of pneumonolysis, apart from the method used, may have played a part.

In the last 100 cases in my series to have pneumonolysis performed, empyema occurred in three cases; two of these cases I would not now consider suitable for pneumonolysis. In the last 75 cases in my series to have pneumonolysis performed, empyema occurred in one case only.

**TABLE V**
(Adapted from Matson)

<table>
<thead>
<tr>
<th>Method</th>
<th>Author's Method</th>
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</thead>
<tbody>
<tr>
<td>Galvano-cautery</td>
<td>Nnamed high-freq</td>
</tr>
<tr>
<td>136 Cases</td>
<td>Bovie high-freq</td>
</tr>
<tr>
<td>Number Percentage</td>
<td>Unit. 35 Cases</td>
</tr>
<tr>
<td>Purulent exudate</td>
<td>Unit. 78 Cases</td>
</tr>
<tr>
<td>Number Percentage</td>
<td>Number Percentage</td>
</tr>
<tr>
<td>36</td>
<td>26.4</td>
</tr>
<tr>
<td>4</td>
<td>11.4</td>
</tr>
<tr>
<td>2</td>
<td>2.5</td>
</tr>
</tbody>
</table>

**Spontaneous Pneumothorax:** Spontaneous pneumothorax has occurred nine times in my series. Eight of these cases have already been mentioned in the discussion of those patients who developed empyema. The remaining patient had several adhesions which I had proposed to free in two stages. The first stage was completed, one adhesion, however, being left partly divided. Convalescence was uneventful until eighteen days following operation, when a refill of air was given. A few hours following this refill spontaneous pneumothorax occurred. The pneumothorax was of the valvular type, and death resulted. The rupture of the lung in the case of this patient was thought to be the result of tearing of the incompletely freed adhesion following the refill of air. This case adds point, I think, to my objection, stated above, to leaving any adhesion partly freed; if this has been done, subsequent refills of air must be given with very great caution, care being exercised that sufficient air is never given to cause the pressure in the pleural cavity at the end of expiration to become positive.

In three of the nine patients in whom spontaneous pneumothorax occurred the rupture of the lung was followed by a persistent broncho-pleural fistula. In one case the fistula appears to have sealed over after being patent for about five months. In one case the fistula remained patent until death occurred ten months later. In the third case, as was noted when discussing the empyema which resulted, the rupture in the lung became sealed over following the original break-through, and indeed spontaneous cure of the empyema seemed to have occurred when,
eighteen months following operation, a second rupture occurred; this rupture has been followed by a persistent broncho-pleural fistula.

The seriousness of spontaneous pneumothorax as a complication of pneumonolysis is exceeded only by the occurrence of massive uncontrollable hemorrhage from a major blood vessel. When spontaneous pneumothorax occurs as a complication of pneumonolysis, empyema is almost certain to follow. Few patients suffering from tuberculous empyema recover from the condition with conservative treatment; in the majority, sooner or later thoracoplasty will become necessary, either to obliterate the pleural space or in the case of the few patients in whom expansion of the lung has taken place, to deal with the lesion in the lung for which artificial pneumothorax was originally induced. As regards those patients in whom the empyema is due to an organism of the pyogenic group, uncomplicated by the presence of tubercle bacilli, the discovery of penicillin has greatly improved the prognosis as regards the empyema; however as cure of the empyema entails expansion of the lung, the lesion in the lung remains to be dealt with, and here again thoracoplasty usually must be considered.

In cases in which a persistent broncho-pleural fistula results the prognosis immediately becomes much more serious still. The seriousness of this complication underlines the necessity for reducing its occurrence to a minimum by scrupulous attention to the details of technique, and by judicious selection of patients for operation. The incidence of spontaneous pneumothorax in Goorwitch's 15 collected series is given as 2.3 per cent and the incidence of broncho-pleural fistula as 2.5 per cent. Although not absolutely clear, it would appear that none of the patients shown as developing broncho-pleural fistula are included among those recorded as having suffered spontaneous pneumothorax. This would give a total incidence of rupture of the lung of 4.8 per cent. (This percentage is relative to the number of operative stages).

Pleur-o-cutaneous Fistula: Pleuro-cutaneous fistula has occurred in five patients, in all as a complication of empyema. Two of these patients have had thoracoplasty performed; in addition to a generally excellent result from this operation in both patients, in one patient the pleuro-cutaneous fistula has closed, and in the other only a small superficial sinus remains. In each of the other three patients the fistula is still patent.

Shock: One patient, a female aged thirty-six years, died about forty-eight hours following operation. Death in this case was attributed to shock resulting from the operation.

This patient had had artificial pneumothorax induced on the right side about four years before her death. She came under my
care about two years following the original induction of pneumothorax, the intervening period having been spent in a sanatorium. When she was seen by me her condition was unstable. Pneumothorax was being maintained on the right side and the lesion in the lung on this side appeared to be under control. She had, however, a small lesion in the left apex and tubercle bacilli were recovered on culture of the fasting stomach contents. Her condition remained unchanged for about fifteen months, after which deterioration was apparent in the lesion in the left lung. Progressive deterioration continued to be evident, both in the patient's general condition and in the lesion in the left lung. About two months before her death, although it was realized that she was a very poor subject, it was decided that the only possibility of halting the spread of the disease was to supplement the bed rest she was then having, with artificial pneumothorax therapy on the left side. Pneumothorax consequently was induced, but was ineffective because of adhesions. She was not a good subject for pneumonolysis, and I hesitated before deciding to submit her to operation; the alternative was, however, to abandon the pneumothorax. Two months were allowed to elapse in the hope that she would become accommodated to the pneumothorax, and as at the end of this period the temperature had been normal for several weeks, it was decided to attempt pneumonolysis. Several apical and subapical adhesions, which offered no technical difficulty, were freed. In addition to these adhesions there were two bands in the mid-zone, at the base of which in each case one or two tubercles were seen; on account of the presence of the tubercles these adhesions were, as I decided, unsuitable for operation. There was one further adhesion present at the extreme apex, the freeing of which I thought might give adequate relaxation of the lung. However, in spite of the fact that up to this stage the operation had not been of a severe character, her general condition was not satisfactory. Dyspnea had been present throughout the operation and appeared to be becoming more pronounced. Consequently I decided not to free this adhesion. Following the operation, her general condition did not show any appreciable improvement, and death occurred about forty-eight hours later. Spontaneous pneumothorax did not occur, nor had there been any hemorrhage. Autopsy was performed and revealed widespread miliary involvement. Death in this patient was, I believe, caused by shock resulting from the operation in a patient whose general resistance had become greatly lowered by a protracted debilitating illness. In view of the finding at autopsy it is unlikely that, in any case, death would have been delayed beyond a couple of months.

This patient was a borderline case in which to attempt pneu-
monolysis, or even for the induction of pneumothorax; however, the latter procedure having been undertaken, pneumonolysis became a logical outcome unless an absolute contraindication should be present. In actual fact this contraindication did exist, in the form of miliary spread, but on the evidence this condition could not be diagnosed before operation.

Obliterative Pleuritis: A late complication of considerable interest, occurring in patients who have been submitted to pneumonolysis, is obliterative pleuritis. This process, as is well known, is a relatively common mode of termination of artificial pneumothorax. Alexander believes that the condition occurs in artificial pneumothorax more frequently in those patients who have had pneumonolysis performed. Since obliterative pleuritis may become evident at any stage during the period in which artificial pneumothorax is being maintained, it follows that the longer a given series of patients is followed the higher will be the incidence of this condition. The tempo of the obliterative process, once it has commenced, is variable. In some cases the process may reach the stage at which the inferior surface of the lung has become adherent to the diaphragm, after which no advance may occur over a considerable period; in this type of case effective pneumothorax may frequently be continued for a considerable time. On the other hand the advance of the process may be relatively rapid and the pneumothorax space become obliterated within a few weeks. A very important factor in the development of obliterative pleuritis is the occurrence of persistent pleural effusion. In some patients, on the contrary, the condition may gradually develop, although little or no fluid may have been noted in the pleural cavity at any period during the maintenance of the pneumothorax.

In recording the incidence of obliterative pleuritis in a series of patients such as the one under review, it is sometimes difficult to decide to what extent, if any, pneumonolysis has been a factor. However, all patients have been included, at whatever period following operation the condition has become evident, whether the process appears to have become stationary at the stage at which the lower surface of the lung has become adherent to the diaphragm or whether it has been possible for the pneumothorax to be continued or not.

Of the 43 patients in my series on whom thorascopic examination only was performed, in the case of one patient obliterative pleuritis became evident about four months following operation. In a relatively high proportion of patients in this group pneumothorax was voluntarily abandoned when it was found impossible to render the collapse effective.

Of the 225 cases in which pneumonolysis was performed, in six,
commencing obliterative pleuritis was evident prior to operation. In two, little advance in the process has taken place and pneumothorax is being continued twenty and twenty-one months respectively subsequent to operation. In one patient the obliterative process showed evidence of progression two months following operation, and four months following operation pneumothorax was abandoned. In one patient, in whom it had been difficult to maintain pneumothorax because of the rapid absorption of air, after about four months the obliterative process was seen to have advanced considerably and the pneumothorax was rapidly lost. In one patient, after four months the obliterative process was noted to be progressing, and eight months following operation pneumothorax was abandoned. In the case of the remaining patient I have been unable to obtain precise information, but the obliterative process appears to have commenced to advance six months following operation and pneumothorax was abandoned a few months later. Of the four cases in which it became necessary to abandon pneumothorax, in two cases postoperative pleural effusion appears to have been a contributing factor in the progress of the obliterative process.

With regard to 219 cases in which no evidence of obliterative pleuritis was noted prior to pneumonolysis, in 28 cases this condition developed at some period subsequent to operation.

Consequently, of 225 cases in which pneumonolysis was carried out, obliterative pleuritis either has occurred, or in cases in which it was present prior to operation has progressed at some period subsequent to operation in a total of 32 cases (14.2 per cent).

In four cases the condition became evident less than three months following operation; in eight cases the period was between three months and six months following operation; in ten cases the period was between six months and twelve months following operation; in five cases the period was over twelve months following operation; in one case the period is uncertain, but it is known that pneumothorax was maintained for thirteen months following operation.

Including the four patients in whom obliterative pleuritis, present before operation, progressed subsequent to operation, in one case it was necessary to abandon pneumothorax less than three months following operation; in three cases the period was between three months and six months; in nine cases the period was between six months and twelve months; in eight cases the period was over twelve months. In eleven cases in which commencing obliterative pleuritis has become evident pneumothorax is still being maintained. In five cases over eighteen months have elapsed since pneumonolysis; in four cases between twelve months and eighteen
months have elapsed; in two cases six months and seven months respectively have elapsed.

In a number of the patients in whom obliteratorive pleuritis has become evident at some period following pneumonolysis, the maintenance of pneumothorax following operation has been of sufficiently long duration for the closure of cavities to have been effected. Of the 32 patients in whom obliterative pleuritis became evident subsequent to pneumonolysis, or in whom a previously existing obliterative pleuritis progressed following pneumonolysis, in 17 cases the occurrence of pleural effusion seems to have been a factor in originating the process, or in causing the process to advance in those cases in which it was evident prior to operation. In 12 cases the effusion occurred in the postoperative period, here considered as the period of two months subsequent to operation. In five cases a varying period elapsed from the time of operation to the occurrence of the effusion.

In Goorwitch's\textsuperscript{13} collected series the occurrence of obliteratorive pleuritis is estimated at 7 per cent. However, in another paper by the same author,\textsuperscript{14} in which he discusses the complications which occurred following closed intrapleural pneumonolysis, carried out on 373 lungs by four surgeons, who operated at the one sanatorium, the incidence of obliterative pleuritis is shown as 85 cases (22.7 per cent). In the latter group of patients, Goorwitch appears to have had better facilities for arriving at an accurate assessment of this complication than in his larger collected series, with regard to which, in the case of a number of authors whose records were consulted, complete data seem to have been lacking. It is probable that the incidence of obliterative pleuritis in the larger series would have been greater than 7 per cent were complete records available.

\textit{Surgical Emphysema:} Surgical emphysema in some degree has been of frequent occurrence in my patients following operation. Tightly applied strapping over a built-up pad of gauze has lessened the degree of emphysema, but except in a few cases has not been completely effective in preventing its occurrence. In a few patients in whom cough has been severe, extensive emphysema has occurred: in two patients extending upwards to the face and into the loose tissues around the eyes, and in one patient extending downward as far as the scrotum. Emphysema in the very great majority of patients, even in those in whom extensive emphysema occurs, is to be regarded as a temporary annoyance only.

In the case of two patients in my series expansion of the lung with loss of the pneumothorax space has occurred. In the first patient partial pneumonolysis only was done. In the case of the second patient extensive pneumonolysis had been carried out and
the lung had been completely freed; however, expansion of the lung occurred, and although it was possible to recollapse the lower zone it was found impossible to recollapse the upper lobe.

The usual explanation of this occurrence is that air escapes from the pleural cavity through the holes made by the trocar, and that the lung expands and becomes adherent to the chest wall. That this is the complete explanation was questioned by Brantigan, Hoffman and Proctor, writing in 1942. These authors reported loss of the pneumothorax space in four patients, following closed pneumonolysis. Fluoroscopic examination had been carried out three hours following operation, when almost complete re-expansion was present. Refills of air were given and repeated in four hours. However, the following day, in one patient complete re-expansion was present and in the other three patients complete expansion of upper and middle lobes had occurred, although partial collapse of the lower lobe was present. Brantigan, Hoffman and Proctor do not believe that excessive leakage of air, *per se*, is the cause of re-expansion of the lung in this type of case. They believe that the presence of endo-bronchial tuberculosis in the main stem bronchus, at the orifice of the branch bronchus, or within the lumen of the branch bronchus, explains the rapid loss of air from the pleural cavity. Following pneumonolysis, there is immediate improved collapse of the lung, accompanied in some cases by kinking of the bronchus. When kinking occurs in those patients in whom endo-bronchial disease is present, obstruction of the bronchus may follow. If the obstruction is complete, atelectasis of the complete lung, or of one lobe, will follow, depending on whether the main stem bronchus or a branch bronchus is involved. However, in cases in which the obstruction is incomplete a check valve action may be initiated. Air passes the obstruction in the bronchus during inspiration, but with the narrowing of the lumen of the bronchus during expiration air remains trapped in the lung distal to the blockage. This mechanism operates with every act of respiration. Rapid expansion of the lung beyond the obstruction consequently occurs. In such cases, then, the re-expanding lung forces air out of the pleural cavity into the tissues, and the concomitant emphysema is thus to be regarded as the result of this re-expansion, and not as its cause. In the four patients reported by Brantigan, Hoffman and Proctor, endo-bronchial disease was later demonstrated.

It has always been difficult for me to understand, in cases of loss of pneumothorax space following pneumonolysis, how adherence between the lung and chest wall occurs so rapidly. I believe that the theory put forward by Brantigan, Hoffman and Proctor offers a satisfactory explanation of what happens in these
patients. Unfortunately, bronchoscopic examination was not carried out in the case of my two patients.

Anderson and Alexander\(^1\) report losing the pneumothorax space once in their 87 patients; of Moore's\(^10\) collected series of 2,043 cases, in six cases the pneumothorax space was lost, and of Drash's\(^10\) 230 cases, in one the pneumothorax was lost. In Goorwitch's\(^15\) collected series of 5,114 cases the incidence of loss of pneumothorax space is given as 3 per cent.

**Postoperative Vomiting:** Postoperative vomiting has occurred in a number of patients. The possibility that the premedication might have had some bearing was considered—morphine and hyoscine were being used at the time; consequently in the case of two patients who were temperamentally suitable, premedication was dispensed with. In one of these patients moderately severe postoperative vomiting occurred. This complication has been noted by Brock,\(^5\) who considers it the result of the manipulation of the pleura and subpleural tissues at operation.

**Dyspnea During Operation:** Dyspnea during operation was complained of by three patients, in two of whom contralateral pneumothorax was being maintained at the time of operation. In two of these cases it was possible to complete the operation, uneventful convalescence following in both cases. In the third case several adhesions were freed, but the operation could not be completed. This patient has already been discussed in the section dealing with shock. Brock\(^5\) reports that in three cases he found it necessary to stop the operation because of this complication and in one case was compelled to abandon the operation completely. In addition to the three patients mentioned, there have been two or three others in whom a minor degree of dyspnea was present during operation. The importance of the dyspnea in the case of these patients was that on account of the large respiratory excursion the operation was rendered much more difficult; in such a patient if an adhesion to be cauterized were situated in a dangerous position, it might be necessary to abandon cauterization because of the hazard.

**Injury to Nerves:** Several patients have complained of numbness of the arm and forearm following operation. This usually passes off during the course of a few weeks. In one patient, while an adhesion was being enucleated the second intercostal nerve was seen and recognized; in this case a little numbness occurred in the upper part of the arm in the distribution of the second dorsal nerve, and tenderness on pressure could be elicited in the second intercostal space anteriorly. This tenderness gradually passed off. In one patient in whom extensive "peeling off" of the apex from the posterior portion of the chest wall was carried out, signs of
Horner's syndrome were noted immediately following operation; eighteen months later a little inequality of the pupils was still present in this patient.

An interesting complication occurred in one female patient in whom three apical bands had been freed. Immediately after operation she noticed that the hand on the same side as that on which pneumonolysis had been performed was warmer than the other. No other objective or subjective sign was present. This sign has persisted up to the time of writing, about six months following operation.

Alexander has noted, in discussing nerve injuries following pneumonolysis, that in one of Saugman's patients paralysis of one-half of the diaphragm followed divisions of an adhesion in the medial part of the chest.

DISCUSSION

From the accumulated experience of many clinics in Europe and America, particularly during the past ten to fifteen years, the value of closed intrapleural pneumonolysis has been abundantly proven. With the aid of pneumonolysis, a useless and dangerous pneumothorax may frequently be rendered effective, with resultant satisfactory relaxation of the lung and, in many cases, closure of cavities and ultimate control of the lesion. Frequently, the patient is saved the necessity of undergoing an extensive plastic operation, which otherwise might be required to save life. In the case of patients in whom active contralateral disease is present, successful pneumonolysis may offer the only prospect of planning a program of treatment which gives to the patient any chance of survival.

The operation is one never to be regarded lightly by the surgeon. A complete knowledge of the pathology of pulmonary tuberculosis is essential, and the structure and mode of formation of pleural adhesions must be fully understood if a requisite technique is to be acquired by the surgeon. Alexander, himself having a wholesome respect for the potential difficulties of the operation takes to task a surgeon who said that, "the technique of cauterization of adhesions, by the Jacobaeus-Unverricht method is simple and free from danger." Alexander's comment is that neither Jacobaeus nor Unverricht held that view. The technical difficulties in the case of the more complex adhesions may be very great indeed. Nevertheless if the operator is experienced, the incidence of serious complications should not be high, and in the case of the more simple adhesions should be relatively rare. Of the 96 patients in my series to have pneumonolysis performed, in whom were present adhesions of the order included in grades I and II
as described above, only one patient suffered any serious complication. With regard to thoracoscopic examination alone, the risk of complication occurring in patients submitted to this procedure should be very small indeed.

SUMMARY

The procedure of closed intrapleural pneunonolysis has been discussed. The results in a series of patients submitted to operation are reported and the postoperative complications are reviewed.

RESUMEN

Se ha discutido el procedimiento de la neumonolis intrapleural cerrada. Se comunican los resultados obtenidos en una serie de enfermos sometidos a la operación y se analizan las complicaciones postoperatorias.

REFERENCES

1 Anderson, R. S., and Alexander, J.: Cited by Alexander, loco citato.
5 Brock, R. S.: "Thoracoscopy and Cauterization of Adhesions: Experiences and Views Based on 442 Consecutive Cases," Brompton Hospital Reports, 7:81, 1939.
17 Joannides, M.: Cited by Drash, loco citato.