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CLOSED INTRAPLEURAL PNEUMOLYSIS

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Artificial pneumothorax has been established for a number of years as a therapeutic measure in pulmonary tuberculosis. While there have been many successful results, there have also been many failures, associated for the most part with adhesions preventing the complete collapse of the diseased area of the lung. The operation of internal pneumolysis was devised by Jacobaeus to deal with adhesions of this character.

Between February, 1936, and December, 1937, 235 patients were operated on by one of us (P. W. E.): 260 operations were done on 255 pneumothoraces. The number of pneumothoraces exceeds the number of patients because in twenty patients with bilateral pneumothorax the operation was carried out on both sides. In five cases only was the operation done in two stages, though in four others a second stage was contemplated but not carried out, as thoracoscopy at a later stage showed that the remaining adhesions were completely inoperable.

TABLE I.—Internal Pneumolysis, February, 1936, to December, 1937

No. of patients	235	No. of operations, 260 :	
No. of pneumothoraces, 255 :		One-stage unilateral	210
(1) Unilateral	215	One-stage bilateral (20 patients)	40
(2) Bilateral (20 patients) ..	40	Two-stage unilateral (5 ..)	10

Clinical Material

Of the patients operated on 50 per cent. were in a far advanced stage of the disease and 42 per cent. were advanced cases. While many of those with very extensive disease had responded to artificial pneumothorax and routine sanatorium treatment, some had failed to show such a response, and internal pneumolysis was carried out in these cases more or less as a last resort.

On admission to the sanatorium the patients were grouped according to the Ministry of Health classification, as follows:

TABLE II.—Clinical Material (235 Cases)

	No.	Per cent.
TB minus	16	7
TB + 1	2	1
TB + 2	99	42
TB + 3	118	50

Operative Results

The numbers and percentages given refer to artificial pneumothoraces.

TABLE III.—Results in 255 Pneumothoraces

Operative Result	No.	Per cent.
Complete	86	34
Partial	140	55
Inoperable	29	11

Complete : All the adhesions seen during the operation cauterized.

Partial : Some of the main adhesions cauterized wholly or partially.

Inoperable : The main adhesions deemed completely uncauterizable.

Complete division of adhesions was possible in only 34 per cent. Jacobaeus (1923) in his early cases obtained a complete collapse in 75 per cent., Chandler (1937) in 50 per cent., Gullbring (1934) in 73 per cent., and Anderson and Alexander (1937) in 37 per cent. The results reported by Jacobaeus, Chandler, and Gullbring were apparently obtained in cases selected as likely to be suitable for the operation, and show a high percentage of technical successes. On the other hand, Anderson and Alexander operated on 111 cases selected from 627 patients undergoing artificial pneumothorax treatment and obtained complete collapse in only 37 per cent. Alexander believes that less than 25 per cent. of patients undergoing artificial pneumothorax treatment are suitable for internal pneumolysis.

In the present series all patients undergoing artificial pneumothorax treatment were submitted for the operation with the exception of a few (less than 10 per cent.), for whom it would obviously have been futile. The results therefore suggest that complete collapse can be obtained by this method in over 30 per cent. of all cases of artificial pneumothorax. Adhesions were partially divided in 55 per cent. (Anderson and Alexander (1937), 41.4 per cent.) and were completely inoperable in 11 per cent. (Anderson and Alexander, 21.6 per cent.). Comparison of the results in this series of unselected cases with the results obtained by Anderson and Alexander in a selected series suggests that Alexander's estimate that less than 25 per cent. of all cases of artificial pneumothorax are suitable for the operation is much too low.

Radiological Result

The result is classified as "satisfactory" when the diseased area is fully collapsed and when cavities, if present before operation, are closed. "Improved, not satisfactory," indicates an improved but not complete collapse, and cavities, if present before operation, are not closed.

TABLE IV

Radiological Result	No.	Per cent.
Satisfactory	100	39
Improvement not satisfactory	35	14
Unaffected	71	28
Partial Symphysis	25	10
Obliterated	24	9
Total	255	100

X-ray films taken before operation were compared with those taken two weeks after operation and with subsequent films, in most cases six months after operation and in some up to nine and twelve months or longer. The radiological results are therefore based in most cases on a series of films, and not on films taken immediately before and after operation. Films taken immediately after operation were found to be misleading in estimating the degree of collapse, as even in inoperable cases they showed an improvement in the collapse chiefly in those parts of the lung in which there was little or no infiltration. This improvement was temporary. The results reveal that the collapse was improved radiologically in 53 per cent. and that the operation was unsuccessful in 47 per cent. in producing a better collapse.

TABLE V.—Comparison between the Operative and the Radiological Result

Operative Result	Radiological Result					
	No.	Satisfactory	Imp. not sat.	Unaffected	Partial Symph.	Oblit.
Complete	86	61 (71%)	12 (14%)	2 (2%)	7 (8%)	4 (5%)
Partial ..	140	39 (28%)	23 (16%)	42 (30%)	18 (13%)	18 (13%)
Inoperable	29	0	0	27 (93%)	0	2 (7%)
Total ..	255	100	35	71	25	24

The successful division of all the adhesions present does not always result in a radiologically satisfactory collapse. After complete division of adhesions, cavities still persisted in 14 per cent., and in 13 per cent. partial or complete obliteration of the pneumothorax followed. In 71 per cent. of pneumothoraces in which all adhesions were divided a radiologically satisfactory result was obtained. Where adhesions were partly divided, radiologically satisfactory results were obtained in 28 per cent., improved but not satisfactory collapse in 16 per cent., and partial or complete obliteration in 26 per cent.; the collapse was unaffected in 30 per cent. In the inoperable group the collapse was unaffected in 93 per cent. and the pneumothorax obliterated in 7 per cent. Partial or complete obliteration of the pneumothorax not infrequently follows the operation (19 per cent.). It is more likely to occur after partial division of adhesions (26 per cent.) than after complete division (13 per cent.).

Comparison is made in Table VI between the radiological result and the position of the principal adhesions

TABLE VI.—Position of the Remaining Adhesions

Radiological Result	Med. Subap.	Med. Apical	Apical Symph.	Lat. Apical	Others	Total
Satisfactory	22	10	3	1	3	39
Improvement not satisfactory	0	13	8	2	0	23
Unaffected	0	5	33	1	3	42
Part. symph.	1	4	11	1	1	18
Obliterated	3	7	6	1	1	18
Total	26	39	61	6	8	140

remaining after partial cauterization. These adhesions were classified as follows: (1) *Medial subapical*: the apex of the lung below the clavicle with the adhesions to the mediastinum below the clavicle. (2) *Medial apical*:

the apex of the lung above the clavicle with adhesions to the medial thoracic wall above the clavicle. (3) *Apical symphysis*: lung adherent to the pleural cupula. (4) *Lateral apical*: adhesions to the lateral thoracic wall above the second rib in the midclavicular line.

As partial division of adhesions resulted in radiologically satisfactory collapse in 28 per cent. of cases it is of interest to note the position of the adhesions that were left undivided. In all cases in which medial subapical adhesions were left undivided a satisfactory collapse was obtained, except in four, in which partial or complete symphysis occurred. As these adhesions are usually attached to important mediastinal structures, their division is often difficult and dangerous. When difficulties arise in dealing with these adhesions and when the apex of the lung is below the clavicle they may be left undivided without interfering with the efficiency of the pneumothorax.

Satisfactory results were much less frequent when medial apical adhesions were left undivided. Of those in which a satisfactory collapse was obtained five had upper-lobe cavities below the level of the clavicle, and these closed after the division of lateral or lateral apical adhesions. In the remaining five there were no cavities before operation. In cases with cavities below the level of the clavicle the division of lateral or lateral apical adhesions may result in closure of the cavities even in the presence of an inoperable medial apical adhesion. Similarly, in cases in which an apical symphysis was left after operation the few satisfactory results followed the division of lateral or lateral apical adhesions where the cavities were below the level of the clavicle before operation. The division of such adhesions is therefore worth attempting.

TABLE VII.—The Radiological Result in TB + 2 and TB + 3 Cases

Classification	No. of A.P.s	Satisfactory		Imp. not sat.		Unaffected		Part. Symph.		Oblit.	
		No.	%	No.	%	No.	%	No.	%	No.	%
TB + 2	94	48	51	12	13	15	16	9	9	10	11
TB + 3	124	42	34	22	18	36	29	14	11	10	8

A satisfactory radiological result was more often obtained in TB + 2 cases (51 per cent.) than in TB + 3 cases (34 per cent.). The operation did not affect the collapse in TB + 2 cases in 16 per cent. and in TB + 3 cases in 29 per cent. Partial and complete symphysis occurred in similar proportions in TB + 2 and TB + 3 cases. As would be expected the more advanced the disease the less successful is the operation in producing satisfactory collapse, though advanced disease (TB + 3) does not contraindicate the operation, as it resulted in a satisfactory collapse in 34 per cent. of cases in this group.

TABLE VIII.—Comparison between Temperature before and Temperature after Operation

Temp before Op.	No. of Ops.	%	Temperature after Operation							
			Transient						Prolonged	
			<99°		<100°		>100°		>100°	
			No.	%	No.	%	No.	%	No.	%
<99°	185	71	42	23	84	45	48	26	11	6
99°–100°	59	23	2	3	22	37	24	41	11	19
>100°	16	6	0	0	2	12	2	12	12	75
Total	260	100	44	17	108	42	74	28	34	13

Most of the operations were performed on patients without pyrexia (71 per cent.), of whom 23 per cent. had no reaction after the operation; transient reactions with pyrexia of less than 100° F. occurred in 45 per cent., and with pyrexia greater than 100° in 26 per cent.; in 6 per cent. prolonged pyrexia followed the operation. In the group with pyrexia between 99° and 100° before operation 3 per cent. were apyrexial, 37 per cent. had transient pyrexia of less than 100°, 41 per cent. had transient pyrexia greater than 100°, and 19 per cent. had prolonged pyrexia after operation. In the group with pyrexia

greater than 100° before operation 75 per cent. had prolonged pyrexia greater than 100° after operation, and in most cases a more marked pyrexia than before operation, while in the remainder the temperature began to settle after the operation was performed.

Temperature reactions are more likely to occur and are more likely to be severe in cases with any degree of pyrexia, but as the operation was followed by a reduction in temperature in some of these cases, pyrexia does not contraindicate the operation in patients in urgent need of it.

Complications

TABLE IX.—Complications (260 Operations)

	No.	%		No.	%
(1) Perforation of Lung ..	6	2.3	(3) Pleural effusion* :		
(2) Haemorrhage :			(a) Transient	20	8.4
(a) Severe ..	1	0.4	(b) Persistent (TB -) ..	26	10.9
(b) Slight ..	6	2.3	(c) Persistent (TB +) ..	32	13.5
Total ..	7	2.7	Total ..	78	32.8

* Omitting twenty-three cases with effusion at time of operation, leaving a total of 237 operations.

Perforation of lung occurred in six cases (2.3 per cent. of operations), in five of which an unsuccessful attempt was made to release a cavity closely attached to the thoracic wall. In the sixth case a complete collapse was obtained after a very extensive cauterization.

Haemorrhage occurred in seven cases (2.7 per cent.). In six it was slight, and was easily controlled with the cautery at low heat. In one case there was an alarming haemorrhage. While working near the apex, blood suddenly covered the lens of the thoracoscope, and several attempts to find the bleeding-point failed. As the patient was becoming collapsed, the cannulae were withdrawn and the head of the bed tilted down. Routine treatment for haemorrhage and shock resulted in recovery, though a temperature reaction lasted many weeks. The pneumothorax was maintained with difficulty, as partial symphysis took place.

Small amounts of fluid in the costo-phrenic angle are common in artificial pneumothorax. A pleural effusion is therefore defined as any quantity of fluid sufficient to cover the diaphragm in the upright position, and all cases with this amount of effusion or more at the time of operation are omitted. Effusions are divided into three classes: (1) transient—those which disappear in a few weeks; (2) persistent (TB -)—those which slowly or rapidly increase and in which tubercle bacilli were never found; (3) persistent (TB +)—as (2), but in which tubercle bacilli were found.

In this series of operations effusions occurred in 32.8 per cent, 8.4 per cent. being transient and 24.4 per cent. persistent. Owing to the lack of a definition of what constitutes an effusion in much of the published work on this subject, it is difficult to compare these figures with those of others. Jacobaeus (1933) in an early series of cases found effusions after operation in 52 per cent., Chandler (1937) in 39 per cent., Anderson and Alexander (1937) in 33.3 per cent., Matson (1935) in 50 per cent., and Brock (1938) in 35.5 per cent. (including 22.5 per cent. classified as "very small amount").

Tuberculous effusions followed the operation in 13.5 per cent. Chandler (1937) had tuberculous empyema in 1.9 per cent., Anderson and Alexander (1937) in 3.6 per cent., and Brock (1928) in 1.4 per cent. of cases. These authors do not

TABLE X.—Comparison between the Radiological Result and the Incidence and Type of Effusion (omitting Inoperable Cases and those with Effusion at Operation)

Type of Effusion	Radiological Result									
	Operations		Satisfactory		Imp. not satis.		Un-affected		Part. Symph.	
	No.	%	No.	%	No.	%	No.	%	No.	%
Nil ..	137	64	72	52	26	19	31	23	3	2
Transient ..	19	9	13	68	2	11	1	5	2	11
Persist. TB - ..	26	12	6	23	2	8	7	27	4	15
Persist. TB + ..	31	15	4	13	3	10	4	13	14	45

state what bacteriological methods were used in examining specimens of fluid for tubercle bacilli. In the present series all specimens were examined by direct film and culture on Loewenstein medium.

Transient effusions had apparently little or no adverse effect on the result of the operation. Satisfactory results in the presence of a transient effusion (68 per cent.) were slightly more frequent than in cases in which no effusion occurred (52 per cent.), but with transient effusions partial symphysis was also more frequent (11 per cent.) than in the absence of an effusion (2 per cent.). Persistent effusions had a definitely adverse effect on the result of the operation. Satisfactory results were much less frequent (for TB negative effusions 23 per cent. and for TB positive effusions 13 per cent.), and the increased incidence of partial symphysis and obliteration was striking, being most marked in TB positive effusions. A persistent effusion is therefore a complication that is likely not only to render the operation valueless but may also lead to the obliteration of a pneumothorax, which, though partial, may nevertheless be of use in some cases.

In view of the disastrous effects of persistent effusions on the results of the operation the relation between the incidence and type of effusion and the severity of the disease (as shown by the Ministry of Health classification), the degree of pyrexia at the time of operation, the sedimentation rate before operation, and the extent of tissue cauterized were investigated. The results are shown in Tables XI to XIV.

TABLE XI.—Incidence and Type of Effusion in TB + 2 and TB + 3 Cases

Classification	No. of Ops.	Incidence of Effusion		Type of Effusion					
				Transient		Persistent TB -		Persistent TB +	
		No.	%	No.	%	No.	%	No.	%
TB + 2 ..	84	25	30	10	40	8	32	7	28
TB + 3 ..	116	46	40	9	19	15	33	22	48

As would be expected the incidence of effusion is greater in TB + 3 cases than in TB + 2 cases. In addition, in TB + 3 cases persistent effusions are more common and transient effusions less common than in TB + 2 cases. Thus in TB + 3 cases effusions are not only more frequent than in TB + 2 cases, but persistent effusions which have often been shown to lead to partial symphysis or obliteration of the pneumothorax are the most common type to occur in this group of cases.

TABLE XII.—Comparison between the Temperature before Operation and the Incidence and Type of Effusion after Operation (omitting Cases with Effusion before Operation)

Temp. before Operation	No. of Ops.	Effusions		Type of Effusion					
				Transient		Persistent TB -		Persistent TB +	
		No.	%	No.	%	No.	%	No.	%
<99° ..	168	47	28	18	38	15	32	14	30
99°-100° ..	55	23	42	2	9	10	43	11	48
>100° ..	14	8	57	0	0	1	12	7	88

In patients without pyrexia at the time of operation not only were effusions less frequent than in those with any degree of pyrexia, but effusions of the persistent type were also less frequent. Even with slight pyrexia effusions were much more common (42 per cent.), and of these over 90 per cent. were persistent. With more marked pyrexia, effusions occurred in almost 60 per cent., and of these 88 per cent. were persistent TB +. It must be remembered, however, that the pyrexial TB + 3 case is the one likely to form an effusion without internal pneumolysis. Consequently, though it is desirable to await a fall in temperature in these cases, careful scrutiny should be maintained lest an effusion form and make internal pneumolysis impossible. A clinical estimate is necessary before performing the operation.

TABLE XIII.—*Comparison between the Sedimentation Rate before Operation and the Incidence and Type of Effusion after Operation (omitting Cases with Effusion before Operation)*

S.R. before Operation	No. of Ops.	Effusions		Type of Effusion					
				Transient		Persistent TB —		Persistent TB +	
		No.	%	No.	%	No.	%	No.	%
Slow ..	73	18	25	10	56	6	33	2	11
Moderate ..	120	38	32	9	24	15	39	14	37
Rapid ..	44	21	48	1	5	5	24	15	71

In patients with slow sedimentation rates at the time of operation effusion occurred in 25 per cent., and of these 56 per cent. were transient and 44 per cent. persistent; whereas, with rapid sedimentation rates, effusions followed cauterization in 48 per cent., of which 95 per cent. were of the persistent type and 71 per cent. were TB positive. As with temperature, delay is desirable before operating if sedimentation is rapid. Only operations urgently necessary should be undertaken in patients with a rapid sedimentation rate—for example, adhesions holding a cavity with evidence of bronchogenic spread in the other lung.

TABLE XIV.—*Comparison between the Extent of Cauterization and the Incidence and Type of Effusion (omitting Cases with Effusion before Operation)*

Extent of Area Cauterized	No. of Ops.	Effusion		Type of Effusion					
				Transient		Persistent TB —		Persistent TB +	
		No.	%	No.	%	No.	%	No.	%
Small ..	36	10	28	5	50	2	20	3	30
Moderate ..	127	47	37	13	28	16	34	18	38
Extensive ..	52	21	40	2	10	8	38	11	52

Where only a few small adhesions were cauterized, effusions occurred in 28 per cent., of which 50 per cent. were transient. The incidence of effusions was much the same after moderate and after extensive cauterization, but in the extensive group there is a much greater incidence of persistent effusion of the TB + type.

It is obvious that advanced disease or any degree of pyrexia or a rapid sedimentation rate is associated with a greatly increased tendency to fluid formation, and particularly to tuberculous empyema. In the presence of any or all of them the possible benefits of the operation must be very carefully weighed against the greatly increased possibility of tuberculous effusions, and especially where an extensive cauterization is likely to be needed.

Radiology in estimating Suitability of Adhesions for Cauterization

Experience with the thoracoscope has shown that with the present methods of radiological examination it is impossible accurately to localize adhesions or to estimate their number and extent or their suitability for cauterization. Radiological shadows which suggest cord-like adhesions are often found at thoracoscopy to be sheets of adhesions, many of which may also be hidden by visible adhesions or by the lung, or may be too thin to show on an ordinary film. In this series an attempt was made to estimate the suitability of adhesions for cauterization by examining antero-posterior films taken before operation. Only those cases in which the greater part or the whole of the apex of the lung appeared radiologically to be directly adherent to the thoracic wall were considered inoperable. The figures given show the result of attempting to cauterize adhesions which, on radiological evidence, appeared to be inoperable owing to the presence of an extensive apical symphysis.

TABLE XV.—*Operative and Radiological Results in Cases with an Apical Symphysis Radiologically before Operation*

Radiological Result	Operative Result				
	Complete	Partial	In-operable	Total	
				No.	%
Satisfactory	Nil	2	0	2	4
Improvement not satisfactory ..	Nil	3	0	3	7
Unaffected	Nil	14	16	30	65
Partial symphysis	Nil	4	0	4	9
Obliterated	Nil	6	1	7	15
Total	Nil	29 (63%)	17 (37%)	46	100

In every case the radiological diagnosis of an apical symphysis was confirmed at operation. It was not possible in any of the cases to free the apex completely. Satisfactory results were obtained in only two instances. In these there were cavities in the middle third of the lung; they were collapsed after division of adhesions to the thoracic wall above the level of the cavities. In three cases there was some improvement of the collapse with diminution in the size of the cavity following division of the outer part of the symphysis.

In many cases the area of lung closely adherent to the thoracic wall at the apex was found at operation to be much greater than it appeared to be radiologically. In several instances there was a symphysis from apex to base posteriorly, though radiologically the symphysis seemed to be confined to the apex. In every case in which the cavity was situated close to the apex the operation had no appreciable effect, even when lateral apical adhesions were successfully divided.

Discussion

Here are reported the results of internal pneumolysis in an unselected series of cases of pulmonary tuberculosis undergoing treatment by artificial pneumothorax. The indication for the operation was the presence of adhesions over the diseased area of lung, and in most cases these were associated with uncollapsed cavities. The decision as to the suitability of adhesions for cauterization depended on a thorascopic examination, though in a few cases the size and position of the pneumothorax in relation to the diseased area showed that thoracoscopy would be valueless or impossible, and accordingly they were not submitted to the operation. Apart from these few cases there was no selection, and the results show the value of the operation of internal pneumolysis in unselected cases of artificial pneumothorax.

The figures given reveal once again the deplorable fact that 50 per cent. of patients treated by artificial pneumothorax were classified TB + 3, and that even in this unpromising material a satisfactory collapse was obtained in 34 per cent., though the incidence of effusions in this group was much greater than in patients with less advanced disease. In TB + 2 cases a satisfactory collapse resulted in 51 per cent.

All adhesions were completely divided in 34 per cent. of pneumothoraces, and radiological examination of these showed a satisfactory collapse in 71 per cent. Complete cauterization of adhesions, therefore, does not always result in a satisfactory collapse, this being due in some cases to effusion, and in others to thick-walled cavities, which in spite of complete relaxation do not close. In 55 per cent. only partial division of adhesions was possible, and of these 28 per cent. showed a satisfactory collapse radiologically.

After partial cauterization it has been found that the position of the remaining adhesions and their relation to cavities have an influence on the efficiency of the collapse. In some positions adhesions are more likely to interfere with efficient collapse than in others. Where the apex of the lung has dropped below the clavicle, medial subapical

adhesions do not prevent the closure of cavities in the upper lobe. These adhesions are usually attached to important structures in the superior mediastinum, and access to them is often difficult; cauterization, too, is dangerous in this area. Such adhesions may be left undivided unless they can be dealt with easily and safely. Medial apical adhesions are important, and should be divided if possible. They may be left, if access is difficult, where a cavity well below the clavicle is held by lateral adhesions that can be cauterized. Edwards and Stevens (1938) found that 42.3 per cent. of cavities uncollapsed by artificial pneumothorax closed after phrenic evulsion, and probably this operation is more effective in the presence of medial apical adhesions than any other type. An apical symphysis is usually inoperable, though parts of such adhesions are sometimes divisible. This, however, does not lead to any obvious improvement in the collapse and may result in the weakening of the walls of an adjacent cavity with perforation of the lung. Cauterization of lateral adhesions in the presence of an apical symphysis has no effect on apical cavities, but may result in closure of cavities below the level of the clavicle.

Apart from effusions there were few complications, though perforation of the lung occurred in 2.3 per cent. In one case (0.4 per cent.) there was a severe intrapleural haemorrhage, and the patient recovered after routine treatment for shock and haemorrhage. Small haemorrhages (2.3 per cent.) were easily controlled by applying the cautery at low heat to the bleeding-point. Varying degrees of surgical emphysema occurred in many cases, and in six it was severe, extending to the neck and abdominal wall. Apart from discomfort to the patient, no ill effects resulted. Mediastinal emphysema was not observed.

Pleural effusion was the most frequent complication, occurring in 32 per cent., excluding cases with effusion at the time of operation. Transient effusions followed the operation in 8 per cent., and persistent effusions in 24 per cent., more than half of which contained tubercle bacilli. Transient effusions had little or no effect on the result of the operation. Persistent effusions, and especially those containing tubercle bacilli, had a definitely adverse effect on the result of the operation, in many cases resulting in partial symphysis or obliteration of the pneumothorax.

In view of the adverse effects of effusions various factors likely to influence the production of effusions were investigated. Effusions, and especially TB + effusions, were much more common in TB + 3 cases. Tuberculous effusions were also more frequent in patients with any degree of pyrexia or a rapid sedimentation rate, or those in whom an extensive cauterization was performed. In dealing with such patients, therefore, the possible advantages of the operation should be carefully weighed against their much greater liability to effusions.

Radiological examination is unreliable in estimating the suitability of adhesions for cauterization; but if there is definite radiological evidence of an apical symphysis with an apical cavity the chances of a successful division of adhesions is extremely remote, and in these cases thoracoscopy is unnecessary. It is advisable, however, to make use of films of higher penetration than is customary in chest radiology, as films of the usual density may show what appears to be an apical symphysis, but which with a film of higher penetration is a series of separate adhesions. In a certain number of cases with upper lobe adhesions stereoscopic films of the upper half of the collapsed side were taken. While these were definitely more reliable than ordinary films in estimating the extent and position of adhesions, they were not accurate enough to warrant their use as a routine.

The age of the pneumothorax at which internal pneumolysis is performed is said by some authorities to influence the incidence of effusion and the success of the operation. In this series of cases the first 121 pneumothoraces were induced from three to nine months before the operation

was performed. In this group complete collapse was obtained in 32 per cent., a radiologically satisfactory collapse in 44 per cent., effusions occurred in 37 per cent., and tuberculous effusions in 13.5 per cent. In the remaining cases the pneumothorax was induced eight to ten weeks before operation. Collapse was complete in 34 per cent., radiologically satisfactory in 35 per cent., effusions occurred in 29 per cent., and tuberculous effusions in 13.5 per cent. Operation more than three months after induction resulted in the division of all adhesions in the same percentage of cases as in those in which the operation was performed within three months of induction, but with a greater proportion of satisfactory radiological results. Effusions were more common in the former group, though the proportion of tuberculous effusions was the same in each. As these groups are probably not strictly comparable in other respects, it is doubtful if the slight differences observed in the results of the operation are significant; there is therefore no definite evidence to suggest that the age of the pneumothorax at which internal pneumolysis is performed, within the age limits stated, has any influence on the success of the operation or the incidence of effusions.

It has been suggested by several authors that the length of the operation has some influence on the result and should be limited to one hour. The extent of the area cauterized appears to have some relation to the incidence of effusion, but it seems unlikely that the time factor alone has any definite relation to the incidence of effusions. It is more probable that the amount of tissue destroyed by cauterization, together with the state of the pleura, is of more significance than the duration of the operation. The amount of tissue destroyed by the cautery in a given time may vary greatly in different patients, depending largely on the technical difficulties encountered, and, in addition, second and third sessions add to the risk of complications. The length of the operation is therefore not a safe guide in deciding on the necessity for a second session, and this should depend rather on the state of the pleura, the extent of the area cauterized, and the technical difficulties, together with the clinical condition of the patient and the sedimentation rate, always bearing in mind the added risk of later sessions.

Double Artificial Pneumothorax

In this series of twenty cases thoracoscopy was performed on the one side before attempting the artificial pneumothorax on the other. As many of these patients were acutely ill the reaction was severe. In the last twenty-nine cases of double artificial pneumothorax this fact has been taken into consideration. If a patient is in good or relatively good condition the thoracoscopy is performed on the one side before inducing the other. If, however, there is a very rapid sedimentation rate, high temperature, or other signs of an acute process in cases in which absolute bed rest alone has failed to reduce toxæmia, thoracoscopy has been postponed and the contralateral side induced at once. The main objection to this procedure is that these cases are liable to pleural effusion. Further, in the very acute cases with much destruction of lung, a phrenic evulsion is performed before doing a thoracoscopy, and this has often resulted in lessening the toxæmia.

Phrenic Evulsion and Thoracoscopy

Normally in cases suitable for a phrenic evulsion this is best performed after the thoracoscopy, as patients with a phrenic evulsion occasionally become short of breath during a thoracoscopy. However, in some cases of artificial pneumothorax with numerous adhesions and only a linear collapse, and where it is impossible to introduce a trocar for thoracoscopy, a phrenic evulsion will result in enough relaxation to permit a thoracoscopy with relative ease. Lastly, in cases of marked toxæmia the phrenic operation may be performed before thoracoscopy.

Summary and Conclusions

The results of internal pneumolysis in an unselected group of 235 cases, in 50 per cent. of which the disease was far advanced, are reported, including twenty with bilateral artificial pneumothorax.

Division of all adhesions was possible in 34 per cent. of pneumothoraces operated on, and partial division in 55 per cent.; 11 per cent. were inoperable.

Radiologically satisfactory results were obtained in 39 per cent., 14 per cent. were improved but not satisfactory, 28 per cent. were unaffected, and in 19 per cent. partial or complete symphysis followed the operation.

In the group of 140 pneumothoraces in which only partial division of adhesions was possible, a satisfactory collapse followed the operation in 28 per cent.

Medial subapical adhesions rarely interfere with efficient collapse where the apex of the lung is below the clavicle in the upright position.

Lateral or lateral apical adhesions may be usefully divided in patients with inoperable medial apical adhesions or apical symphysis in the presence of patent cavities below the level of the clavicle.

Satisfactory results were most frequent with limited lesions in apyrexial patients.

Apart from effusions, complications were rare. Following 260 operations, effusions occurred in 32.8 per cent. of operations (8.4 per cent. transient, 10.9 per cent. persistent TB negative, 13.5 per cent. persistent TB positive). Transient effusions did not materially affect the result of the operation. Results were poor where the operation was followed by persistent effusions, particularly those in which tubercle bacilli were present and the incidence of partial or complete obliteration was high.

Effusions were most common in cases with advanced disease, any degree of pyrexia, rapid sedimentation rates, or in cases where extensive cauterization was carried out. Consideration of the first three of these factors is of importance in estimating the probability of effusion following the operation.

The radiological diagnosis of an inoperable apical symphysis in forty-six cases was confirmed by thoracoscopy. Apart from this group, radiological examination was unreliable in determining the position or extent of the adhesions present. Stereoscopic examination was more reliable than fluoroscopy and antero-posterior films, but was not of enough value to warrant routine use.

Facilities for intrapleural pneumolysis are essential for the proper conduct of artificial pneumothorax treatment, and the operation may be of value even in advanced cases.

The place of double artificial pneumothorax and phrenic evulsion in intrapleural pneumolysis is indicated.

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Disturbances of Epiphyseal Ossification.—The hip-joint is the site at which hereditary disturbances of epiphyseal ossification may most often be found, but any epiphysis in the body may be affected. The condition has to be differentiated from Perthes's disease and allied abnormalities, but the non-traumatic form of osteochondritis dissecans is thought by the author to be closely related to it.—Multiple Hereditary Disturbances of Epiphyseal Ossification. W. Müller.—*Z. Orthop.*, May 30, 1939, 69, 257.

LABORATORY METHODS IN THE
DIAGNOSIS AND CONTROL OF FEVERS
OF THE ENTERIC GROUP*

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In a very brief paper such as this it is impossible to do more than touch on a few of the principal points in which progress has been made in diagnosing and controlling fevers of the enteric group. To those who practise at home it may seem that the existing methods of laboratory diagnosis are adequate and satisfactory, but unfortunately in subjects who have been inoculated with typhoid-paratyphoid vaccine—and this includes practically all Europeans living over-seas—the usual serological tests give very equivocal and unreliable results. In the accompanying table the figures for the British and Indian Armies for the last ten years are shown. The cases classified as "enteric group" have been diagnosed on serological or clinical grounds, and there is good reason to believe that a considerable proportion of them are not true enteric group fevers. It is unlikely that there will be any notable increase in the number of cases diagnosed by cultural methods; for, in the Army, blood culture as well as faeces and urine culture is pursued relentlessly. In outbreaks of typhoid or paratyphoid fever, isolations are made from practically 100 per cent. of the cases: the enteric group cases in the table are mainly sporadic cases,

Table showing Incidence of Enteric Group Fevers in the Army in India (British and Indian Troops Combined)

	1928	1929	1930	1931	1932	1933	1934	1935	1936	1937
Typhoid { Cases	227	293	200	176	161	137	105	82	43	42
Deaths	33	41	21	25	21	26	16	16	5	?
Para A { Cases	45	58	68	64	67	52	53	59	27	25
Deaths	—	—	1	3	1	1	—	3	—	?
Para B { Cases	18	9	6	10	10	3	4	1	2	2
Deaths	—	—	—	—	—	—	—	—	—	?
Para C { Cases	4	12	9	4	1	3	3	—	1	—
Deaths	—	2	1	—	—	—	—	—	—	—
Enteric Group { Cases	264	237	218	240	205	222	148	128	80	55
Deaths	12	9	9	11	10	10	6	3	3	?
Total { Cases	558	609	501	494	444	417	313	270	153	124
Deaths	45	52	32	39	32	37	22	22	8	?

in many of which the diagnosis has been made because nothing else seems to apply. It is obvious that a serological test capable of giving reliable positives and negatives would be of the greatest value.

The usual agglutination test made with suspensions of H or flagella antigen, eminently successful in the un-inoculated, has now been completely given up in the military laboratories of India, for it has been conclusively shown that, in subjects inoculated with typhoid-paratyphoid vaccine, febrile conditions other than enteric group fevers produce an anamnestic rise of agglutinins not to be distinguished from that given by enteric infection. Routine tests are now being performed with suspensions of O antigen. These are undoubtedly more specific in their indications, being less influenced by the stimulus of non-

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