THE RESULTS OF PNEUMOTHORAX TREATMENT OF PULMONARY TUBERCULOSIS.*

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THOUGH pneumothorax treatment of pulmonary tuberculosis has for several years made itself respected, the statistics of the final results are yet only scarce. As Brauer has pointed out, it is, on the whole, very difficult to compile statistics of the patients thus treated because they belong to the most severe cases, and each of them has its own peculiarity. A detailed communication of the cases, one by one, gives much fuller information. But having now at Vejleford Sanatorium more than 12 years' experience and a material consisting of over 400 pneumothorax-treated patients, I think our numbers are sufficiently great for statistical analysis.

Since December, 1906, we have treated in our sanatorium 430 patients,¹ with about 10,000 punctures in all. As to the risk of the first injection of gas through a sharp needle (having only in a few cases employed Kuss's blunt trocar), I would remark that after the two cases of sudden death (Nos. 98 and 163, which occurred in 1910 and 1912, and which have already been reported²), i.e., in a series of 277 cases,³ we have had no accident at the induction of the pneumothorax, so that the mortality of the first operation in our material has sunk below $\frac{1}{2}$ per cent. The two cases mentioned above were probably due to gas embolism, though it could not be proved by the post-mortem examination. With our present cautious technique we have seen no dangerous complications from the injections of gas.

In order to judge the results of pneumothorax treatment I have investigated the after-histories of the patients discharged from 1907 to 1916, and whose records were known to the sanatorium in January, 1919. Certain inquiries also refer to patients belonging to 1917. During these 10 years 275 patients (about 57 per cent. women, about 60 per cent. left-sided), in whom collapse treatment had been tried, were discharged from the sanatorium. Six of these suffered from non-tuberculous diseases (bronchiectases, consequences of gangrene of the lung, tumours) and are excluded, together with the two cases of death at the first injection and, besides, eight patients who later on were treated by thoracoplasty during or after their stay in the sanatorium, and thus are of no importance in the judgment of the results of pneumothorax treatment. Consequently, 259 patients remain. They all belong to the third stage, except two cases in the second stage, in which we tried collapse treatment because they did not seem for a long time to improve under general sanatorium treatment. Strange to say, the attempts in both cases failed on account of total pleural adhesions. By continued sanatorium treatment they have gradually recovered, and their disease may now be regarded as arrested.⁴

The others—i.e., 257 patients—belonged to the third stage, and in all these cases tubercle bacilli were found in the sputum. In 172 cases we succeeded in forming a pneumothorax, though not always a large one; while our attempts in 85 cases (i.e., 32 per cent.) did not result in the formation of an efficient pneumothorax.

In the after-histories of these 85 patients we have a standard for comparison. The cases are quite similar to those in which the treatment was technically effective; the only difference is that the one series could be treated in this way and the other not. Consequently we can from the after-histories of these 85 patients in some measure conclude how the 172 others would have fared if pneumothorax treatment had not been employed and had not influenced their

condition favourably or otherwise. Only this objection might be raised that cases with total adhesion of the pleuræ have a worse prognosis than others; this is, however, contradicted by the even excellent results that in such cases can be obtained by thoracoplasty, results that are by no means inferior to the results of pneumothorax treatment. In this group we also have a standard of the quality of the whole material. By a comparison with the final results of another series of third-stage, sputum-positive cases collected in 1911 these cases show that after 2-10 $\frac{1}{2}$ years 25 per cent. were able to work and 69 per cent. were dead, while our series of controls, collected in the same way, shows respectively 13 per cent. and 80 per cent. Consequently this material has been even considerably more serious than the average of the third-stage cases with bacilli.

The inquiries into the after-histories of these two series of patients in January, 1919, are indicated in Table IA., this table including all cases that have been treated. Yet this table does not give any real index of the importance of pneumothorax treatment because it includes a great many quite hopeless cases, which were treated partly *ut aliquid fiat*, partly *solaminis causa*. Of course, such cases are absolutely unimportant in the judgment of the value of a method. Therefore it is just to exclude all the hopeless patients—i.e., partly such whose better lung can hardly be expected to do the work of two, and partly such whose symptoms of intestinal tuberculosis have appeared either before or immediately after the beginning of the treatment. Further, there are the cases in which the treatment had at once a bad influence, and was therefore quickly abandoned. The material thus somewhat sifted gives a better idea of the importance of the treatment, although there is among the remaining cases a large series in which the indications for the treatment, on account of the state of the other lung, were rather—or even very—dubious. The results of the two series, after this exclusion, is seen from Table IB.

Patients Discharged 1907-16 Inclusive; Their Condition in January, 1919.

TABLE IA.—The Complete Unsifted Material (257 patients).

TABLE IB.—The Same Table after Exclusion of the Quite Hopeless Cases (220 patients).

	(A)				(B)			
	Treatment technically				Treatment technically			
	Effective.		Ineffective.		Effective.		Ineffective.	
	No.	Per cent.	No.	Per cent.	No.	Per cent.	No.	Per cent.
Able to do general or light work.	55	32	9	10.6	55	38.5	9	11.8
Unable to work on account of tuberculosis.	5	2.9	3	3.5	5	3.5	3	3.9
Dead from tuberculosis.	109	63.4	71	83.5	80	55.9	63	81.8
Ill or dead from other causes.	3	1.7	—	—	3	2.1	—	—
Unknown.	—	—	2	2.4	—	—	2	2.6
—	172	—	85	—	143	—	77	—

I may add that 16 of the 55 patients classed as able to work are still undergoing treatment, while 39 have ceased treatment. Bacilli had disappeared in 39 per cent. of the treated cases, only in 12 per cent. of the untreated.

We see that the number of those who in 1919—i.e., 2-11 $\frac{1}{2}$ years after discharge—could be classed as able to do general or light work in the "effective" cases is more than three times as great as in the "ineffective" cases, while the mortality is only about two-thirds. My assistant, Johannes Gravesen, has recently demonstrated the following very interesting fact: in cases of complete pneumothorax without notable adhesions the percentage of capacity for work after 3-13 years was about 70; in cases of incomplete pneumothorax only about 11. Table II. gives an idea of the fate of these patients during some years, showing the state of all patients from 1-10 years after discharge of the complete and of the sifted material.

* A lecture delivered at the Ninth Scandinavian Medical Congress in Copenhagen on August 20th, 1919.

¹ To the beginning of August, 1920, 500 patients.

² Saugman: Zur Technik des künstlichen Pneumothorax, Brauer's Beiträge, vol. xxxi., 1914.

³ To the beginning of August, 1920, 337 cases.

⁴ One of them died in January, 1920, from influenza.

TABLE II.—(A) *The Complete, Unsifted Material (1907–17).* (B) *The Same Table with Exclusion of the Hopeless Cases.*

After years:	(A)																				(B)																			
	Treatment technically										Treatment technically										Treatment technically										Treatment technically									
	Effective (per cent.).										Ineffective (per cent.).										Effective (per cent.).										Ineffective (per cent.).									
	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	10
Can do general or light work.	35	36	33	30	26	24	27	18	17	20	17	17	19	17	15	16	13	16	0	0	42	45	41	37	31	30	32	23	26	30	20	19	21	19	17	14	16	19	0	0
Unable to work.*	25	17	12	9	6	4	4	4	0	0	22	22	17	12	8	4	3	5	0	0	25	18	13	10	6	5	5	5	0	0	23	25	18	13	11	8	4	6	0	0
Died of tuberculosis.	40	47	55	61	68	71	69	78	83	80	60	60	63	72	77	80	83	79	100	100	32	37	46	53	62	65	63	72	74	70	56	56	60	68	72	74	80	75	100	100
No. of cases ...	194	175	159	140	117	98	75	50	29	15	88	81	71	60	52	44	30	19	18	2	161	142	132	114	96	80	63	39	19	10	78	73	65	54	46	39	25	16	6	1

* On account of tuberculosis.

From Table IIA. I have excluded the numbers after the seventh year as being too small, and therefore rather accidental, and have composed the curves here shown.

These tables and curves show that of the technically effective cases, after 3 years, more than 40 per cent., and, after seven years, 32 per cent. were still able to work; the parallel numbers per cent. for the technically ineffective cases are 21 and 16—i.e., about half. Likewise the curve of mortality shows for the former group after three years 46 per cent., after seven years 63 per cent., but for the latter 60 and 80 per cent. In fact, Curve I. shows what can be effected by ordinary sanatorium treatment for such cases as are suitable for pneumothorax treatment (the lower curve), and the plus that pneumothorax treatment gives—viz., the distance from the lower curve to the upper one.

All these numbers give plain evidence of the exceedingly favourable influence of Forlanini's treatment on suitable cases and of the really excellent results that can be obtained by this treatment in combination with sanatorium treatment. I do not know any other treatment that gives third-stage, sputum-positive cases a 33 per cent. chance of being able to work after seven years.

Of the patients discharged 1907–17, 22 are still undergoing pneumothorax treatment; 20 of them are able to work, 2 not.

TABLE III.

Pneumothorax is maintained (1919) in—		
1 for 11 years.	1 for 6 years.	4 for 3 years.
1 „ 9 „	4 „ 5 „	5 „ 2 „
1 „ 7 „	5 „ 4 „	

Particular interest is, of course, attached to those whose treatment has been terminated and whose health during a number of years has been maintained. In January, 1919, 44 of the patients discharged 1907–17 with treatment terminated can be classed as able to work. The interval since the cessation of the treatment is seen from Table IV. :—

TABLE IV.

In 44 patients discharged 1907–17, who in 1919 were classed as able to work, pneumothorax treatment had been terminated—		
1 ... 12 years ago.	5 ... 7 years ago.	6 ... 3 years ago.
1 ... 10 „ „	3 ... 6 „ „	6 ... 2 „ „
2 ... 9 „ „	7 ... 5 „ „	7 ... 1 „ „
3 ... 8 „ „	2 ... 4 „ „	1 ... ? „ „

In these cases the compression has lasted in—

1 ... ½ year.	17 ... 2–3 years.	1 ... 5–6 years.
2 ... 1–1 ½ „	7 ... 3–4 „	2 ... 6–7 „
11 ... 1–2 years.	2 ... 4–5 „	1 ... ? „

All these patients now do their usual work without any regard to their previous illness, partly in very laborious professions.

Of real relapses in patients whose treatment had been intentionally terminated we have had only 4, to which may be added 2, in whom the treatment ought to have been continued, but was terminated by a mistake. The relapses supervened after a compression for—

> 1 year ... in 1 case, | 3–4 years ... in 2 cases,
1–2 years ... „ 1 „ | 4–5 „ ... „ 2 „

while the time that passed, before the relapse was evident, was :—

> ½ year ... in 2 cases. | 3 years ... in 1 case.
1 „ ... „ 1 case. | 4 „ ... „ 1 „
2 years ... „ 1 „

We have treated 4 of these patients again; in 1 of

FIG. 1.—Curve of Working Capacity.

FIG. 2.—Curve of Mortality.

them a pneumothorax could be re-formed, the gas not being completely reabsorbed; but extension of the disease in the other lung supervened. In the other 3 cases our attempts to re-establish the pneumothorax had no result; 2 of them were treated with thoracoplasty, 1, according to Friedrich's method, with a negative result, the other, according to Sauerbruch's method, with a comparatively favourable result.

I have, by a careful analysis of these cases, tried to find why relapse supervened in one and not in another case, but I have failed. I think we may consider it a somewhat dangerous thing to cease the treatment before the lapse of more than one year, because one of the four compressions had only lasted one year. When peculiar circumstances favour it, in very recent cases when the lung has not fibrosed and when the pneumothorax is complete, it will perhaps be sufficient to continue the treatment for only one year; but usually at least two years' compression will be preferable. In chronic cases I am much afraid of discontinuing the treatment before three or four years, and even after four years relapses are, as seen from one of our cases, not impossible. The cessation of a pneumothorax is always, in a measure, a risk, so we must not blame our patients for wishing to continue the treatment when they have seen in their companions relapses after its cessation, and when they are well with their pneumothorax. In such cases it will usually be sufficient, when the treatment has lasted for

some years, to inject gas every second or third month, and the inconveniences of these injections are mostly so slight that the sense of security given is cheaply bought. A patient who during several years has been treated with a pneumothorax with good results feels, apart from a little dyspnoea, quite well and is able to work like a healthy man, unless hard physical exertion is required. For instance, a busy medical practitioner has continued his work for five years without trouble, although he had to cycle during last winter's epidemic of influenza when benzene was scarce. The only real risk such a patient runs is that of pneumonia in the other lung. We have had one such case; the patient was a young medical man, who had been treated during six years for a practically hopeless condition, and had been able to finish his studies and do his hospital work. Perhaps he might have been saved if he had allowed the gas to be withdrawn from his pneumothorax, which he, being over-cautious, had kept superfluously large; but there was no chance of performing such an evacuation. The post-mortem examination in this case showed complete healing of the lung; there was a cavity completely compressed. Examination of a series of slides of its walls showed one single giant cell; but bacilli could not be found, and inoculation of a guinea-pig gave a negative result. This man could, no doubt, have let his lung re-expand long ago; at any rate, it would have been sufficient to maintain a very small pneumothorax, which would have allowed the "sick" lung to work again, while a thin space of air would have been kept up with a view to an enlargement should this be necessary.

In the case of incomplete but efficient compression it will usually be right to continue the pneumothorax treatment for good, unless the treatment is abandoned in favour of a total or partial thoracoplasty, which will, in many cases, be preferable.

The pneumothorax being complete, I now usually let the patients be treated for about five years. If then all is normal, if the patient's capacity for work is proved, and if he wishes it, I let the pneumothorax close, choosing the summer season for allowing the lung to re-expand, for the first months observing the patient very closely, if possible in the sanatorium; and no sooner do symptoms of relapse in the treated lung appear than I renew the injections of gas, but only in very few cases have I seen any reason to do so. After seeing the excellent results that can be obtained by thoracoplasty, I am not so afraid to discontinue the treatment; if a relapse occurs and the pneumothorax cannot be re-formed we can operate on the patient.

Three of our patients have been confined without relapse, one of them even twice, one pregnancy occurring before, the other after the cessation of the pneumothorax, which had lasted five years. In three cases pregnancy occurred so soon after discharge that I did not venture to let it continue.

Of alternating compression, first of one, then of the other lung, we have had 7 cases, 2 patients, discharged in 1918, being included. They all died except one, who first had his left lung compressed for eight months, with cessation in July, 1913, and in whose right side a pneumothorax was formed in January, 1914, which lasted 16 months. Since 1915 he has been quite well and able to work. Though such an alternating treatment in most cases will be without result, it is seen that in single cases it can be of use, and we therefore are justified in employing it, especially when there is a rather long interval between the cessation of the first and the beginning of the second treatment.

An effusion in the pneumothorax cavity is one of the most frequent complications; of our 143 patients 79 had an effusion in the sanatorium (31 large, 23 middle-sized, and 25 small), in 4 cases an effusion was found at the induction of the pneumothorax. It is of great interest to examine the influence of effusions on the final results. In Table V. the state in 1919 of those with and of those without an effusion is shown. It is astonishing that the results of the two series are practically identical, with a slight preponderance in favour of the dry pneumothorax cases. It is still more astonishing that many of the patients now completely fit for

work have passed through severe suppurative pleurisies with tubercle bacilli in the pus, and persisting for several years.

TABLE V.—The Influence of an Effusion on the Results.

	With effusion.		Without effusion.	
	No.	Per cent.	No.	Per cent.
Able to work in Jan., 1919	31	37·3	24	40·0
Unable to work	4	4·8	1	1·6
Dead, Jan., 1919	48	57·8	32	53·3
Ill or dead from other } causes, Jan., 1919 ... }	—	—	3	5·0

I hope that the facts now communicated may be sufficient to indicate the great importance of pneumothorax treatment in suitable cases. But I would again, in conclusion, emphasise that the results here mentioned are obtained by a combination of pneumothorax treatment with strict sanatorium treatment. It is easily understood that the best possible conditions for the "better" lung, of which, especially in the beginning of the treatment, much is required, are of importance, and these conditions are best found in a sanatorium. My patients, as a class, are comparatively well-to-do.

A surgical colleague remarked a couple of years ago that he hoped to become old enough to see the burial of pneumothorax treatment. He did not live long enough, however, and though he had lived ever so many years he would not have seen it. The pneumothorax treatment has got a permanent place as an important remedy in our therapeutic armoury, a place that only ignorance of the methods and its results can deny. It is not unjustly that Holmgren in his chapter in the Scandinavian Text-book of Medicine characterises it as the greatest progress made in the treatment of phthisis since Brehmer's and Dettweiler's time. I would be glad if the numbers here presented convince sceptics of the great importance of the method.

ON THE CLINICAL VALUE OF
ROUTINE CEREBRO-SPINAL FLUID
EXAMINATION

IN THE DIAGNOSIS OF NERVOUS DISEASE.

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IN acute meningeal affections examination of the cerebro-spinal fluid forms a routine part of every clinical laboratory's working day, but not, as far as one can gather, in the more chronic neurological affections, though just as brilliant diagnostic results are claimed in such cases by an army of workers throughout America and the continent. I wish, therefore, to lay before the profession some results which have been obtained during over a year's work on material gathered from the various Liverpool institutions. These results will be treated in a purely clinical spirit, leaving the more technical part of the subject for a future paper. An outline only of the technique employed will be given.

Lumbar Puncture.

This operation, in my opinion, should never be performed unless provision is made for the patient to remain in bed during the ensuing 24 hours. The sitting-up position is, when possible, much to be preferred, and as a rule no anæsthetic, either general or local, is required. The choice of needle is a difficult one; in my own practice I have always two different kinds ready sterilised: a White-Jeanselm needle of platinum-iridium and a nickel needle of the ordinary Barker type. The former is to be preferred, but it has two objections: (1) that if the patient is abnormally fat or muscular or if the needle be introduced at too great an angle the thecal cavity may not be reached owing to