LATE RESULTS OF CLOSED INTRAPLEURAL PNEUMOLYSIS

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The difficulties of statistical evaluation of artificial pneumothorax treatment are well known. It is now recognized that crude statistics such as those of Drolet (1943) and Soderstrom (1941)—which do not take account of the effectiveness of the collapse—are weighted against pneumothorax by the inclusion of a large proportion of cases in which the A.P. was either useless or positively harmful (Rafferty, 1943).

The late results of pneumothorax treatment depend largely on the efficiency of the collapse obtained (Hjaltestad and Törning, 1939; Jennings *et al.*, 1940), and since it has been shown that it is possible, by the use of internal pneumolysis, to improve the collapse in a large proportion of pneumothoraces (Edwards and Lynn, 1939; Wollaston, 1940), it seems to us that for the efficient practice of pneumothorax treatment this operation should be readily available and should be freely used when indicated.

Edwards and Lynn (1939) reported the immediate result of internal pneumolysis on 235 patients. These have now been followed up for five years. Bilateral operations and thorascopies without division of adhesions have been excluded from this series, and the number brought up to 200 consecutive cases of pulmonary tuberculosis treated by artificial pneumothorax with unilateral division of adhesions by closed intrapleural pneumolysis. When the indications existed this treatment was supplemented by phrenic evulsion (110 cases), and all patients underwent a strict course of sanatorium routine.

All patients were classified according to the Ministry of Health classification on admission to the sanatorium. The poor quality of the clinical material is shown by the fact that 41% of the series fell into the T.B. + 3 group, 49% were T.B. + 2, and the remaining 10% were either T.B. + 1 or T.B. minus. In all but seven of the 200 cases there was cavitation in the treated lung, and 97 had multiple cavities.

Radiological Result of Operation

The present series of 200 pneumothoraces with pneumolysis have been grouped according to the degree of collapse obtained as estimated from a study of serial post-operative films; the survival of the different groups is shown in Table I. Group I

TABLE I.—Survival 5 Years after Operation according to Degree of Collapse

	Group	No.	Alive	% Alive	L.S.O.
Satisfactory	I	28	21	75	1
	II	36	50	89	1
Incomplete	III	12	7	58	—
	IV	28	19	68	—
Ineffective	V	76	36	47.5	—
		200	133	66.5	2

indicates a pneumothorax in which there is complete relaxation of the apex with no adhesions to the lateral chest wall or upper mediastinum. In Group II the lung is free of the chest wall but there are adhesions to the upper mediastinum below the level of the clavicle. Several patients in these two groups had unimportant basal adhesions associated with upper-zone disease. Group III includes all cases with the lung completely freed except for adhesions to the mediastinum as far up as the apico-mediastinal angle. In Group IV the lung apex was adherent to the cupula. Group V includes those cases in which there was massive adherence of the apex to the dome of the chest and all cases in which there were inoperable adhesions to the lateral chest-wall irrespective of the apical relaxation. Before operation none of the cases had a collapse which could be classed as Group I or II.

Edwards and Lynn (1939) found that the immediate effect of pneumothorax was not impaired by undivided adhesions to the mediastinum below the level of the clavicle. From Table I it appears that these adhesions are also without harmful effect on the late results.

It is worthy of note that these findings are not in agreement with those of Jeanneret and Gilliard (1942), who insist that for full effect the freeing of the lung must be carried as far as the hilum on the mediastinal aspect. Collapse of this nature was present in 55 of their 300 cases of pneumothorax, 20 without pneumolysis, and of these 55 cases 49 (89%) were found to be efficacious after six months. In the present series, it is shown in Table I that of 56 cases with mediastinal adhesions below the level of the clavicle, 50 (89%) are alive five years after operation. We are of the opinion that adhesions to the medial thoracic wall below the level of the clavicle are in most cases without effect on the course of the pneumothorax, and that operation in this area can often be both meddlesome and dangerous.

In cases with adhesions either to the apico-mediastinal angle (Group III) or the cupula (Group IV) the survival rate is distinctly less satisfactory. So far as deductions can be made from such small figures, it seems to us that the removal of some apical adhesions is of small benefit to the patient unless the apex can be dropped below the level of the clavicle. In the 76 cases with ineffective pneumothorax (Group V) the survival of only 47.5% is an indication of the small therapeutic value of this type of collapse.

Since we have found the cases in Group II to have survived at least as well as Group I, both as a whole and when other factors were controlled, we have in the subsequent tables combined the groups into a class designated "satisfactory collapse." For the same reasons Groups III and IV have been combined as "incomplete collapse."

In the "satisfactory collapse" group it was possible to follow 81 of the 84 patients for six years after operation, and some more detail was available as to their present condition:

Number of patients	..	..	..	..	..	84
Total alive	..	..	..	..	..	69
Well and working	..	..	..	..	..	56
Unable to work	..	..	..	..	..	13
Dead	..	..	..	..	..	12
Lost sight of	..	..	..	..	..	3

Of the 56 who were working 52 had completed their treatment, and the other four had their disease well controlled with refills at intervals up to 10 weeks. One patient had died in the sixth year, and one had been lost sight of.

Ministry of Health Classification on Admission

The Ministry of Health classification on admission is correlated with the radiological result and survival in Table II.

TABLE II.—Classification on Admission. Correlated with Degree of Collapse and Survival 5 Years after Operation

	T.B. Minus			T.B. + 1			T.B. + 2			T.B. + 3		
	No.	A	% A	No.	A	% A	No.	A	% A	No.	A	% A
Satisfactory	7	7	100	2	2	100	44	40	91	29	22	76
Incomplete	5	4	80	—	—	—	18	14	78	17	8	47
Ineffective	6	5	83	—	—	—	34	17	50	36	14	39
Totals	18	16	89	2	2	100	96	71	74	82	44	54

The survival of even 54% of T.B.+3 patients for 5 years is not unsatisfactory. An effective pneumothorax in this same class improves this figure to 76%. The number in the T.B. minus group is too small to warrant any conclusions, but the survival of 16 of the 18 is in keeping with the good prognosis for patients with negative sputum after operation, which is apparent in a later table.

State of Contralateral Lung

The contralateral lung was classified as "good" when it was clear or when minimal infiltration was present, and as "bad" when there was cavitation or massive infiltration likely to progress to early cavitation. Eleven cases with ineffective artificial pneumothorax without pneumolysis on the contralateral side were included in the "bad" group. Intermediate cases were classified as "moderate." The state of the contra-

lateral lung is correlated with the radiological result of operation and survival in Table III. Of the 198 cases 93 (47%) had

TABLE III.—*State of Contralateral Lung. Correlated with Degree of Collapse and Survival 5 Years after Operation*

	Good			Moderate			Bad or A.P.		
	No.	A	% A	No.	A	% A	No.	A	% A
Satisfactory	25	23	92	26*	25	96	31*	23	74
Incomplete	11	9	82	9	6	67	20	11	55
Ineffective	16	11	69	18	9	50	42	16	38
Totals	52	43	83	53	40	76	93	50	54

* 1 accidental death.

advanced disease in the contralateral lung, and this group accounted for 77% of all the deaths. There was no death from tuberculosis among the 26 patients with a satisfactory collapse accompanied by moderate infiltration of the contralateral lung. The survival of 74% of those with satisfactory collapse and contralateral cavitation was unexpectedly high and noteworthy. These findings support the view that control of the disease in one lung favours healing in the other.

The prognosis for the tuberculous patient with bilateral cavitation is always poor, and in our series contralateral artificial pneumothorax was either impossible or unsatisfactory. So artificial pneumothorax with pneumolysis was the most radical treatment applicable to them. A small proportion would nowadays become candidates for contralateral partial thoracoplasty, but in this class of case "many are called but few are chosen."

Sputum

Sputum was negative or absent three months after operation in 138 (70%) of the 198 patients who were followed up. Of these sputum-negative patients 109 (79%) survived five years, compared with only 40% survival in the sputum-positive group. The great majority of the negative findings were confirmed by concentration and culture.

The correlation between the state of the sputum three months after operation and the degree of collapse obtained is shown in Table IV. It is noteworthy that only one of the 65 sputum-

TABLE IV.—*Sputum 3 Months after Operation. Correlated with Degree of Collapse and Survival 5 Years after Operation*

	Negative			Positive		
	No.	A	% A	No.	A	% A
Satisfactory	65*	62	96	17	9	53
Incomplete	25	19	76	15	7	47
Ineffective	48	28	57.5	28	8	29
Totals	138	109	79	60	24	40

* 2 accidental deaths.

negative patients with satisfactory collapse died of pulmonary tuberculosis. In 13 of the 17 sputum-positive cases with satisfactory collapse the contralateral lung was classified as bad, and was the probable source of the positive sputum.

In the "incomplete collapse" group the survival of 76% of the sputum-negative cases suggests that a considerable number of these artificial pneumothoraces are worth maintaining, provided control of the disease is indicated by negative sputum. Of the 15 sputum-positive cases in this group only 7 survived. Since a contralateral origin for the bacilli could not be excluded in 6 of the 8 patients who are dead, we do not feel that any conclusions can be drawn from these small figures. But throughout the series the prognosis is gloomy for the patient whose sputum remains positive, and it is imperative that every other possible method of treatment should be considered. Unfortunately the hard core of untreatable cases remains distressingly large.

Altogether Table IV suggests very strongly that the achievement of a negative sputum is quite as important for the patient himself as for his contacts.

Extent of Area Cauterized

In every case the operator (P. W. E.) described the adhesions divided and estimated the area of the burnt surface of the

peripheral stumps. According to this estimate, the extent of area cauterized was classified as small when only strings and thin bands were divided, moderate, and large. Only very extensive cauterizations were included in the "large" group.

Of the 82 satisfactory collapses 66 were the result of moderate or large cauteries. The proportion of different sizes of cauteries was similar in the other two collapse groups except for a slightly greater incidence of large cauteries in the ineffective group. The size of cautery has been correlated with the radiological result of operation and survival rate in Table V. It

TABLE V.—*Extent of Area Cauterized. Correlated with Degree of Collapse and Survival 5 Years after Operation*

	Small			Moderate			Large		
	No.	A	% A	No.	A	% A	No.	A	% A
Satisfactory	16	14	88	55*	46	84	11	11	100
Incomplete	9	6	67	24	15	61	7	5	72
Ineffective	14	4	29	47	26	55	15	6	40
Totals	39	24	61.5	126	87	69	33	22	65.5

* 2 accidental deaths.

appears that, in this series, size of burn did not have a significant effect on the prognosis, although Edwards and Lynn (1939) found that the incidence of effusion was higher in extensive burns and that the effusions tended to be persistent in type. The majority of the empyemata occurred in the ineffective group.

Effusions

Enough fluid to cover the dome of the diaphragm in the upright position has been classed as an effusion, and smaller amounts have been disregarded. This quantity of fluid, or more, occurred in 103 of the 198 cases followed up. In 46 of these cases the fluid disappeared in a short time without aspiration. In cases in which the fluid persisted we aimed at keeping the pleura as dry as possible, and all fluid specimens were examined by direct film and culture for tubercle bacilli and pyogenic organisms.

The survival of patients having the different types of effusion is shown in Table VI. Here it is apparent that effusions which

TABLE VI.—*Effect of Effusions on Survival 5 Years after Operation*

Effusions	No.	A	% A
Nil	95	68	72
Transient	46	36	78
Clear T.B.	24	15	63
Clear T.B. +	15	8	54
Tuberculous empyema	9	4	44
Mixed empyema	9	2	22

quickly clear up have no ill effect. The prognosis in cases progressing to empyema is of course bad. We found, however, that the total deaths attributable to this cause were 12, in 7 of which cases the collapse was ineffective.

Discussion

As experience of artificial pneumothorax treatment has increased, more and more tuberculosis physicians have come to accept the view, often expressed by one of us (Edwards, Ann. Reps. Cheshire Joint Sanatorium), that the result of pneumothorax depends on the efficiency of the collapse. Since the general adoption of internal pneumolysis, the standard of what constitutes an efficient collapse has become more rigid, and the aim is a complete relaxation of the lung. Hjaltestad and Törning (1939) have found that their patients in whom a good pneumothorax was the result of internal pneumolysis fared at least as well as those in whom the same type of collapse was present without operation. In the present series 84 patients had satisfactory relaxation of the diseased lung as a result of internal pneumolysis. Furthermore, we have found that throughout our series the collapse obtained as the result of an extensive cauterization was no less effective than that in which smaller or fewer adhesions were divided.

In those patients on whom operation carries special risk by reason of the anatomical character of the adhesions or the poor general condition of the subject, alternatives to artificial pneumothorax must be considered. But when contralateral

disease allows of no more radical alternative the operative risk must be accepted, for success in obtaining a satisfactory collapse carries with it some prospect of improvement in the contralateral disease. The abandonment of the pneumothorax without thoracoscopy and the maintenance of an unsatisfactory collapse are both bad practice.

Summary and Conclusions

The state of 200 cases of unilateral internal pneumolysis 5 years after operation is reported.

Of these cases 2 were lost sight of in this period. 133 (66.5%) survived 5 years. 71 (86.5%) of those cases in which a satisfactory collapse was obtained by operation survived 5 years, and 56 of these were well and working after 6 years: none of them had a satisfactory collapse before operation.

A satisfactory collapse on one side seems to have greatly improved the prospect of survival in cases with bilateral cavitation.

The persistence of positive sputum 3 months after division of adhesions indicates a poor prognosis. On the other hand, a negative sputum improves the outlook in the "incomplete" and "ineffective" collapse groups.

Tuberculous empyema, especially when secondary infection is present, is a serious complication, but it accounted for only 18% of the deaths in 5 years.

If artificial pneumothorax is employed the aim should be to obtain the most complete collapse possible by the use of internal pneumolysis.

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HIGH-TONE DEAFNESS IN SCHOOL-CHILDREN SIMULATING MENTAL DEFECT

BY

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Some years ago, after several examinations, I certified as mentally defective a girl aged 9 who had been referred to me in school as a case of backwardness associated with speech so rudimentary that the child was practically dumb. She was said to hear normally. She came when she was called and she had every appearance of understanding simple orders and requests. I verified this by several rough tests such as calling her name loudly, ringing bells, beating an enamel bowl, clapping my hands, etc., behind her back at distances ranging from one to ten feet. She never failed to turn immediately with a bright eager smile. Her elder sister had been a certified defective and had attended a special school. There had been no question of deafness in the older girl's case: the diagnosis appeared only too obvious. In the special school, however, with its better opportunities for individual observation and teaching, it was soon apparent that the child's general behaviour, muscular control, and handwork were vastly superior to that of her classmates, and the possibility of some unusual form of deafness was considered. She was sent to the Department of Education for the Deaf at Manchester University, where Dr. and Mrs. Ewing were conducting their first work in audiometry. The audiogram at once showed that the child possessed only "islands of hearing." She was transferred to the Royal School for the Deaf at Old Trafford, where, since her intelligence was actually of a high order, she responded most satisfactorily to Dr. and Mrs. Ewing's (1938) methods of combined lip-reading and hearing-aid methods.

This case, and a somewhat similar one, prompted me to investigate the whole subject of speech and language from the physical rather than the psychological point of view, and I

was granted the privilege of studying phonetics and audiometry in Mrs. Ewing's department at the University. As my ear became more sensitive to fine distinctions in sound, and my eyes more observant to detect slight differences in the articulatory movements of the tongue and lips, I began to distinguish innumerable sound substitutions and omissions of which I had hitherto been more or less oblivious. It was soon obvious—as every speech therapist knows—that these substitutions and omissions followed definite patterns. My problem was to discover, if possible, why the same patterns kept recurring. It occurred to me that some sort of classification according to sex, age, and intelligence would be useful for the purposes of the survey. I decided to exclude cases of "baby speech" under 5 years of age. Over a period of three years I examined the speech of some thousands of elementary-school children between the ages of 5 and 14 in London, Manchester, and Cornwall. These places were chosen because the local accents differ very widely and because facilities happened to be available to me. The investigation was later widened to include some hundreds of secondary-school children of corresponding age groups: 100 certified mental defectives; 100 blind children; and finally 100 children known, from pure-tone audiometric examination, to be suffering from impaired hearing. Examination of this last group was made possible through the kindness of Dr. J. L. Burn, the medical officer of health for Salford, who had conducted a hearing survey of his entire school population, using first a group pure-tone test and then giving an individual pure-tone test to those who failed to reach the normal level in the first test. The detailed findings of the survey are too lengthy and complicated to give here, but it gradually became apparent that defects of speech are most commonly found in mentally retarded children and in children with impaired hearing; and that, although the patterns of speech defect were very similar in the two groups, certain sound substitutions and omissions were more often associated with impaired hearing, and certain others with mental retardation. *Vowel sounds* were only rarely interchanged: the nasal sounds (m, n, and ng) were usually correct (although occasionally "n" would be substituted for "ng" after the manner of our "huntin'" and "fishin'" forebears); but the sounds represented in ordinary script by the letters r, l, w, and y were fairly often substituted for each other, so that a "rabbit" might be a "labbit," a "wabbit," or a "yabbit," and a "little lamb" might be a "ritter ramb" or a "yitty yamb." The sounds of "t" and "d" were often omitted, especially at the ends of words. These same sounds, which are "front stops," were very frequently substituted for the back stops, "k" and "g" (this "cup of cocoa" became "tup of toto"); but the most frequently defective sounds of all were those of "s," "f," and "th" and their voiced equivalents "z," "v," and "th" (voiced). The "s" defects included substitutions by "th" (the common "lisp"), "sh," "t," and a sort of voiceless "l" rather like the Welsh "ll" sound in the word "Llewellyn." No less than 83% of my cases in which a defect of "s" was the sole defect present were associated with malocclusion of the jaws (Seth and Guthrie (1935) give a 90% association), and the frequency with which I either observed thumb-sucking myself or obtained a history of the habit from the mothers leaves no doubt in my mind of the permanently harmful effects of this practice. The most common substitution of all in the elementary-school children, the blind children, and the mental defectives was "f" for "th" (e.g., "thirty-three things" would be "firty-free fings"). This defect did not once occur in the secondary-school group, probably because the intelligent child, even if his hearing is slightly impaired, rapidly learns to distinguish these sounds by their lip movements and by their different visual symbols in reading-books. It was not so common in the hard-of-hearing group as defects of "s" and "r," doubtless for the same reason.

It is to Dr. Harvey Fletcher (1929), the physicist employed by the Western Electric Film Co. in research on the transmission of speech sounds, that we owe the invention of the audiometer. A complete description of the chart or audiogram and how it was evolved is given in his book. Otologists have been using the audiometer to diagnose deafness for so many years that it is unnecessary to describe it here; but for the sake of those who are not familiar with the chart it may be said that the normal "speech range" extends over some 6½ octaves, from