

THE REMOTE RESULTS OF COLLAPSE THERAPY  
IN THE TREATMENT OF PULMONARY TUBERCULOSIS.

Lung collapse as a method of treatment of pulmonary tuberculosis has been in vogue now for over 25 years and a great mass of literature on the subject has accumulated both in this country and abroad. The use of the method is universal and there can be no doubt that in individual cases the operator is often considerably impressed, and with good reason, by the immediate results of his treatment. Even in those cases where the patient still retains a positive sputum after collapse treatment considerable satisfaction can be derived from the fact that the patient may have gained one or two stones in weight, his symptoms may have been ameliorated, and there has probably been a marked improvement in his physical condition. From a sanatorium such patients still with a positive sputum are discharged to their homes, in many cases leaving the operator with a feeling that he has accomplished something, and that although his treatment has only been partially successful, it will at any rate, prolong the patient's life. The occasional patient who relapses and is readmitted is regarded as an unfortunate but more or less isolated case. The fact is of course that institutional treatment comprises only a small part of the patient's tuberculous history, and

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as the terminal results of collapse treatment in a group of patients may be spread over a number of years, the remote results are not as a rule obvious. The object of this investigation is to show primarily how much of the confidence with which a patient with a positive sputum is discharged is justified in the light of statistical fact. There are two groups of patients who leave a sanatorium having had collapse therapy - those with a negative sputum and those still with a positive sputum. This paper deals with the ultimate fate of these two groups separately, and the results are not surprising. Those patients who are fortunate enough to have had their sputum converted to T.B. negative show an extremely promising survival rate, almost 70% surviving for 10 years. On the other hand, those patients who after treatment by collapse methods, still retain a T.B. positive sputum, show a survival rate which is probably the worst of the tuberculous population as a whole. The impression to be gained from studying the figures which follow is that as far as remote results of treatment are concerned, this latter group of patients is at the bottom of the prognostic ladder, and that out of any 100 such patients only 5 or 6 will live for 10 years.

The material for this investigation is provided by 630 patients over the age of 10 years, who were treated for pulmonary tuberculosis in one of the Kent County

sanatoria during the years 1925 to 1940. It has been possible therefore, to observe all these patients for a minimum period of five years, and some of them for up to almost twenty years. For the purpose of this paper only those patients upon whom some form of collapse therapy was performed are considered, so that it may be possible to compare on a fairly large scale the remote results of collapse treatment with the fate of the tuberculous population as a whole. To be certain that the diagnosis of pulmonary tuberculosis was correct in every case, only those patients in whose cases tubercle bacilli were demonstrated in the sputum at some time or other have been considered. The patients were drawn from the whole of the County of Kent, and pursued all types of employment from industry to agriculture. All patients had first class sanatorium accommodation available within a few weeks of diagnosis. Apart from artificial pneumothorax, the forms of surgical treatment employed included extra-pleural pneumothorax, phrenic crush, thoracoplasty, and adhesion section, and these operations were carried out in the main at the London Chest Hospital. The following table shows the number and nature of the operations performed:-

TABLE I

Thoracoplasty	53 patients
Adhesion Section	106 "
Phrenic Crush	85 "
Phrenic Evulsion	5 "
Extra-pleural pneumothorax	9 "

It must be agreed at the outset, however, that the type of patient under consideration comes from a selected group in that all patients were suitable for some form of collapse therapy, and the fact that they all received sanatorium treatment in itself indicates that they were patients with a relatively favourable prognosis, as sanatoria as a rule do not admit patients for whom little can be done. Furthermore, up to the beginning of the last war, the selection of patients for collapse therapy was limited to a certain extent by the conservative methods then in use, and also by the fact that facilities for thoracic surgery were not so readily available then as they are now. This means in effect that the vast majority of patients suffered from unilateral lesions only, and the induction of a bilateral pneumothorax was generally performed on account of spread of the disease to the contralateral lung of a patient already having collapse treatment.

In actual fact a bilateral pneumothorax was induced in 40 patients (6.3%). Again, as this investigation is aimed at ascertaining the results of successful collapse therapy, those patients in whose cases an ineffective pneumothorax was maintained for less than three months are excluded. A further point to note is that the period of survival is reckoned from the date on which the disease was first diagnosed, and the period of institutional treatment is included in the period of survival.

The number of patients lost sight of was 37 or 5.8%. Many of these were patients transferred to other areas, and available information stops short of the date of their transfer. They are therefore lost sight of as far as this paper is concerned, although there is reason to believe that some of them have survived for considerable periods following the date they were lost sight of.

Of the 630 patients, 348 were male and 282 were female (55.2% and 44.8% respectively). Artificial pneumothorax was induced on the right side in 299 cases (47.4%) and on the left side in 291 cases (46.2%). The remainder were bilateral cases. The distribution in age groups is shown in Table II, but as all sputum negative forms of tuberculosis are excluded, and the remainder comprise a highly selected group, comparison with standard rates is of little material value,

except that as is to be expected the greatest incidence is in the 15 to 30 year group. The average duration of institutional treatment for all patients under consideration was 240 days.

TABLE II - Age Groups

Sex	10-14	15-19	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	Total
Male	3	56	85	78	64	35	13	12	1	1	348
Female	10	50	69	62	44	33	11	2	1	-	282

Of the total number, 278 patients are now known to be dead, and the fatality incidence is indicated in Table III

TABLE III - Fatality Incidence.

Deaths in each succeeding year following diagnosis.

1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	Over 10	Total
27	46	44	42	31	24	21	13	8	5	17	278

Expressed in percentage form the fatality rates are as follows. In each year succeeding the first five years during which all 630 patients were observed those survivors ceasing to be observed together with those lost sight of are deleted from the table after the Life Table method of Bradford Hill. (1)

TABLE IV - Fatality Rates.

Within 1 year of observation of 630 patients	27	died =	4.3%
" 2 " s "	626	" 73 " =	11.7%
" 3 " "	622	" 117 " =	18.8%
" 4 " "	619	" 159 " =	25.7%
" 5 " "	616	" 190 " =	30.8%
" 6 " "	611	" 214 " =	35.0%
" 7 " "	564	" 235 " =	41.7%
" 8 " "	529	" 248 " =	46.9%
" 9 " "	496	" 256 " =	51.6%
" 10 " "	451	" 261 " =	57.9%

17 patients who survived for more than 10 years are known to have died subsequently.

In 395 patients (62.7%) collapse treatment resulted in the sputum being converted from positive to negative. This result was not always achieved easily and many patients had adhesion section performed several times or had to submit to thoracoplasty before a satisfactory result was obtained. It is of very great interest however to be able to compare the fatality rates of these 395 patients with those of the remaining 235 patients in whose cases collapse therapy did not result in sputum conversion. The results for the first group of patients are shown in Table V and for the second group in Table VI.



TABLE V.

Fatality Rates in patients where treatment resulted in sputum conversion.

Within 1 year of observation of 395 patients	2 died	-	0.5%
" 2 years	" 8 "	"	2.0%
" 3 "	" 22 "	"	5.6%
" 4 "	" 39 "	"	10.0%
" 5 "	" 56 "	"	14.4%
" 6 "	" 64 "	"	16.7%
" 7 "	" 73 "	"	20.8%
" 8 "	" 78 "	"	23.9%
" 9 "	" 83 "	"	27.5%
" 10 "	" 88 "	"	32.8%

10 patients who survived for more than 10 years are known to have died subsequently.

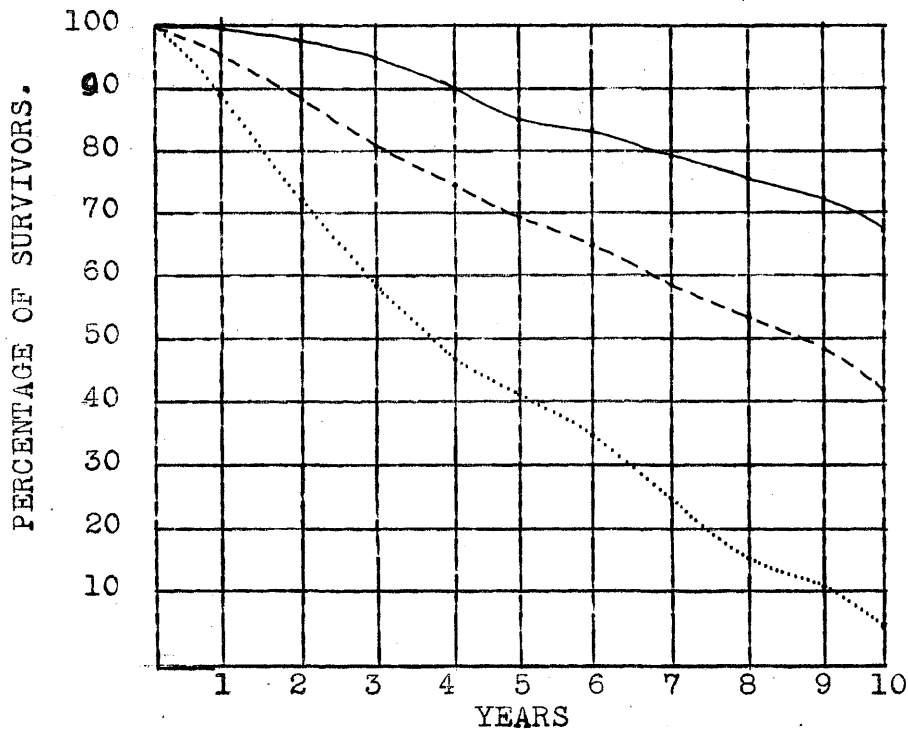
TABLE VI.

Fatality Rates in patients where treatment did not result in sputum conversion.

Within 1 year of observation of 235 patients	25 died	-	10.6%
" 2 "s	" 65 "	"	27.9%
" 3 "	" 95 "	"	41.5%
" 4 "	" 120 "	"	52.6%
" 5 "	" 134 "	"	58.2%
" 6 "	" 150 "	"	65.8%
" 7 "	" 162 "	"	76.1%
" 8 "	" 170 "	"	83.7%
" 9 "	" 173 "	"	86.2%
" 10 "	" 173 "	"	94.5%

7 patients who survived for more than 10 years are known to have died subsequently.

The difference in these comparative tables is more strikingly demonstrated graphically thus -



- ALL CASES.
- \_\_\_\_\_ NEGATIVE SPUTUM GROUP.
- ..... POSITIVE SPUTUM GROUP.

It will be seen from the foregoing tables that whereas in considering all cases together, over two-thirds of the patients were alive at the end of five years and just less than one-half at the end of ten years, in those cases where treatment resulted in sputum conversion 85.6% were alive at the end of five years and 67.2% at the end of ten years. On the other hand in those cases where treatment failed to bring about sputum conversion 41.2% were alive at the end of five years and only 5.5% at the end of ten years. It is immediately obvious therefore that success in treatment must in the main be judged by the production of a negative sputum. To carry this point further the incidence of complications in the two groups of patients under discussion was investigated with the results shown in Table VII.

Unfortunately it was not possible to obtain detailed clinical records of every patient as in a number of cases these had been destroyed by enemy action. Clinical notes were available of 291 patients who had produced a negative sputum, and of 165 patients who had not.

TABLE VII.

Complication	Negative Cases.		Positive Cases.	
	Number	Percentage	Number	Percentage
Pyopneumothorax	4	1.4	12	7.3
Hydropneumothorax	41	15.2	85	51.5
Tuberculous Laryngitis	3	1.0	3	1.8
Tuberculous Enteritis	1	0.3	1	0.6
Haemoptysis	3	1.0	10	6.0
Spontaneous pneumothorax	-	-	3	1.8
Bone and Joint Tuberculosis	1	0.3	1	0.6

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It will be appreciated from studying Table VII therefore that although the numbers are small, the incidence of complications always appears to be greater in cases where collapse treatment has failed to bring about conversion of the sputum, particularly with regard to the incidence of effusion and pyopneumothorax. It may be noted here that in those cases of the negative sputum group where such complications as tuberculous laryngitis or enteritis occurred these were always preceded by a break-down of the tuberculous lesion, extension of the disease to the contra-lateral lung and the reappearance of a positive sputum at periods varying from one to eight years following the initial production of a negative sputum.

Cause of Death:- Of the 278 patients who died 173 were in the positive sputum group and 105 in the negative sputum group. An attempt was made to ascertain the cause of death in all cases, and while this was comparatively easy in the case of those patients who still retained a positive sputum after treatment and who generally died in one of the Council's institutions, it was a matter of considerable difficulty in the case of those patients where treatment had resulted in a negative sputum, mainly because of the greater length of time which elapsed between diagnosis and death, and the fact that most of these patients died at home, together with the fact that a large percentage of the records of these patients was lost by enemy action. In the positive sputum group the causes of death were as follows:-

TABLE VIII

Cause of death	Number of patients	Percentage.
Contralateral spread	157	90.8
Haemoptysis	5	2.9
Post-operative pneumonia	3	1.7
Rupture of pulmonary vein during thoracoplasty operation	1	0.6
Tuberculous bronchopneumonia	2	1.1
Tuberculous pyopneumothorax	4	2.3
Accidentally drowned.	1	0.6
	<hr/> 173 <hr/>	

As far as could be ascertained the following table shows the cause of death in the negative sputum group. Unfortunately, in 43 cases all records were lost owing to enemy action and in those cases it was found impossible to ascertain the cause of death. The cause of death in the remaining 62 patients was obtained to a large extent from the death register of the Medical Officer of Health of the area in which the patient had resided.

TABLE IX.

Cause of death	Number of patients	Percentage
Pulmonary Tuberculosis	56	90.3
Haemoptysis	2	3.2
Tuberculous enteritis	1	1.6
Tuberculous broncho-pneumonia	1	1.6
Tuberculous empyema	1	1.6
Operation for empyema (Organism not stated)	1	1.6
	<hr/> 62 <hr/>	

It is not possible to make any dogmatic conclusion from the above table because not only are the numbers small but the certified causes of death are not supported by any clinical records.

However, 33 of the above cases died in one of the Council's institutions. This group included all those who died from causes other than pulmonary tuberculosis and in 29 of these death was preceded by the reappearance of a positive sputum. It will be noted therefore that this present analysis points to the fact that while successful collapse may cause a patient's expectation of life to be considerably prolonged, it does not appreciably alter the ultimate cause of his death.

#### DISCUSSION.

It is extremely difficult to evaluate accurately the results of treatment in a disease such as pulmonary tuberculosis where so many variable factors such as the virulence of the infecting organism, the patient's age, sex, resistance and economic circumstances etc. arise to cloud the issue. Tuberculosis is a disease of surprises and unaccountable failures and does not lend itself to unbiased statistical handling.

In an account published by Dr. Brian Thompson in 1942<sup>2</sup> of the fate of 406 patients suffering from all degrees of pulmonary tuberculosis in Durham between the years 1928 and 1938 it was observed that more than three-quarters of the patients were dead within five years and barely one-eighth lived for ten years. Somewhat corresponding figures were published in a report issued by the Chief Medical Officer of the County of Lancashire in 1933,<sup>3</sup> of a follow-up for three-and-a-half years

of patients notified as sputum positive in 1930. The percentage of survivors was 30.4. The Durham figures are salutary in that they indicate that of any 100 positive sputum patients 75 may be dead within five years and only 12 or 13 live for ten years. The figures of both these investigations are however based on a number of patients, in a considerable proportion of whose cases the disease was too far advanced to be remediable. In fact in the Durham series almost 20% of the total died within three months of being discovered to be suffering from pulmonary tuberculosis, and a further 11% died during the second three months.

The report of the Chief Medical Officer of the London County Council published in 1937<sup>4</sup> showing the results of an investigation into the fate of 2696 patients with a positive sputum discharged from sanatorium in 1931 showed that five years later, of the early group of cases 77.8% were still alive, of the intermediate group 41.1%, and of the advanced group 7.8% only were alive. The high fatality rate was again recently indicated in a Ministry of Health publication by the fact that, taking the most recent London County Council figures available, out of 3,446 adult patients with pulmonary tuberculosis discharged from the Council's tuberculosis hospitals and sanatoria in 1933, only 43 per cent were alive five years later. In these cases of course the period of survival was reckoned from the date of discharge from sanatorium and not from the date the



disease was first diagnosed. The picture is even gloomier if reference is made to an investigation into the period of survival from the date of diagnosis made by E. Lewis-Faning<sup>6</sup> in the County of Middlesex in 1943 where it was shown that of 2201 patients of both sexes and all ages, only 13% survived more than five years.

Reference to figures published in America By H.E. Holleboe<sup>7</sup> in 1941 of the post-sanatorium tuberculosis survival rates in Minnesota based on a follow-up of 10,990 persons shows that the survival rate of a moderately advanced group of sputum positive cases was 41.6% after six years, and of a far advanced group was 25.4% compared with a corresponding figure of 65% for all the patients observed in this investigation, and 83.3% for the patients in whose cases collapse therapy had resulted in the production of a negative sputum.

Coming to a more selected group of patients for purposes of further comparison, selected in that they came from the higher wage-earning population and suffered mainly from early or moderately early forms of the disease, the report of the King Edward VII Sanatorium, Midhurst issued in 1939,<sup>8</sup> showed that of 608 patients with a positive sputum and who had received sanatorium treatment, 60% were alive at the end of five years and 43.5% survived ten years, figures which approximate to the results obtained in the patients with whom this investigation is concerned (69.2% and 42.1% respectively).

Reference to the Midhurst report, however, also shows that of all patients admitted during 1938 for instance, 87.7% were suffering from early or moderately early forms of the disease, which, together with the figures of the present series emphasises particularly the benefit to be derived from treating early cases.

Early Diagnosis. "There is abundant evidence that the prognosis for patients with symptomatic minimal pulmonary tuberculosis, when contrasted with that for patients with more advanced disease, is relatively favourable. Furthermore, apart from the prognostic significance of early diagnosis and treatment for the individual patient, the successful treatment of minimal cases constitutes perhaps the most effective practicable method of diminishing the source of infection from which the disease continued to be spread in the community" (W.D.W. Brooks).<sup>9</sup>

There can be no doubt that success in the treatment of pulmonary tuberculosis can best be achieved by the discovery of the disease in its earliest stages, and the figures in this series support this contention. The difficulty is, however, that early forms of the disease may give rise to no symptoms of which the patient is aware, or at the most to vague symptoms which are usually ascribed by the sufferer to more benign causes and may not be referred to the chest at all. Established symptoms which compel the patient to consult his doctor of his own accord generally indicate that the disease is moderately advanced, sometimes too far advanced for collapse therapy to be

carried out without some difficulty. Under these circumstances the number of early cases discovered has not been great. In the London County Council area in 1927<sup>10</sup> for example, only 20% of notified cases of pulmonary tuberculosis were classified in Groups A and B1, i.e. cases in which tubercle bacilli had not been demonstrated in the sputum and early sputum-positive cases respectively, and much the same position obtained in 1937<sup>11</sup> (Bentley and Leitner). Lateness of diagnosis was again illustrated in a Ministry of Health publication recently,<sup>12</sup> by the fact that of 35,000 pulmonary tuberculosis patients discharged from, or dying in, hospitals and sanatoria in England and Wales during 1938, as many as 65% had been classified at the time of admission as intermediate or advanced cases, although at that time waiting lists were either non-existent or negligible. Here it may be noted that P.W. Edwards was able to banish tubercle bacilli from the sputum of all B1 cases, but this was only possible in 66% and 21% respectively of B2 and B3 cases, i.e. open cases suffering from moderately advanced and advanced disease.<sup>13</sup>

The expansion of H.M. Government's mass miniature radiography scheme, and the increasing examination of contacts together with the education of the public should be of inestimable value in detecting the early case and in enabling treatment to be commenced at a stage when the disease can be more readily controlled. In this connection Brooks,<sup>14</sup> in a

fluorographic examination of 479,373 apparently healthy male personnel of the Royal Navy showed that 1.27% had radiological signs of adult type pulmonary tuberculosis, and of 23,344 W.R.N.S. 0.91% had similar evidence of pulmonary tuberculosis. In a series of 680 full-sized radiographs of apparently healthy office workers examined by the writer in 1945, 4 were found to have active early lung lesions, (0.6%), one with a positive sputum, and in the other three tubercle bacilli were discovered by gastric lavage.

With regard to the examination of contacts the London County Council report for 1937<sup>15</sup> shows that of 6,933 patients who had undergone residential treatment under the Council's tuberculosis scheme, some 31.3% had a history of contact of some kind, while P.W. Edwards reports a positive family history in 38% of patients admitted to the Cheshire Joint Sanatorium,<sup>16</sup> during the years 1940-41.

Early Treatment. Consideration of the problem of early diagnosis naturally brings us to consideration of the provision of early treatment, and in this connection the existing facilities for the provision of this treatment must be viewed with some disquiet. Doctors Gray and Topping in their Survey of the Hospital Services of London and the Surrounding Area<sup>17</sup> state that the evidence they have received from various sources suggests that it is by no means extravagant to budget for 1.5 (or even 2) beds for every death from pulmonary tuberculosis.

In the area with which their report was concerned there was on this basis a deficiency of 2,000 beds, a fact which is confirmed by long waiting lists, by the need of tuberculosis authorities to seek beds in other areas, and by the complaints of doctors and others about the difficulty in arranging prompt treatment. During the war the incidence of tuberculosis has increased and pressure on existing accommodation has become even more acute. In this connection the report of the County Medical Officer of Kent for the year 1944<sup>18</sup> must be viewed with some alarm. In 1944 the number of male patients in Kent requiring treatment for tuberculosis had increased by almost 40% over the 1935 figure, while for women the increase over the same period was 116%. This means in effect that approximately 4-6 months may elapse before accommodation for treatment can be provided, and as far as can be ascertained by local enquiry the position is as bad in other Counties. This state of affairs has resulted in a vicious circle, for an early case which might be readily controlled if given early treatment may present a big problem four or five months later from the point of view of adequate collapse therapy. Nowadays it is comparatively rare to see early cases of pulmonary tuberculosis in the sanatoria under the control of Local Authorities, whose duty lies in the provision of treatment for the mass of the tuberculous population rather than to individual patients, and it is therefore only institutions under voluntary control,

who have an opportunity of selecting their patients, who admit early cases. As has been mentioned before, of the total admissions during the year 1938 to King Edward VII Santatorium, Midhurst, 87.7% were suffering from early disease, and in 1943, of 273 patients admitted to the National Sanatorium, Benenden, another voluntary institution, 50.5% were suffering from early or moderately early forms of the disease.

To cope with the problem of the provision of early treatment there has been instituted in Kent a system whereby some 20 beds in one of the large County establishments have been reserved for the admission of patients suffering from early disease, so that if necessary, collapse therapy can be commenced at an early stage when the possibility of complications is small. If a satisfactory collapse is obtained with no adhesions these patients are retained only for a period of from four to six weeks, thereafter being discharged to their homes by ambulance to have their refills maintained by the District Tuberculosis Officers. In the meantime their names are retained on the general sanatorium waiting list so that in their turn they receive the benefits of prolonged institutional treatment. It is realised that this procedure may prove to be unsatisfactory, and may not be without danger, but as a desperate remedy was necessary the risk has been taken. It is too early yet to give any indication as to the success or failure of the venture.

It appears certain that efficient collapse therapy still offers the patient the best chance of recovery, but in this connection must again be emphasized the striking difference in the results obtained in those cases where such treatment has resulted in sputum conversion compared with those in which a positive sputum persists. In the latter group of cases the end results are no better, and the suggestion is made that by introducing the added complications of an unsatisfactory collapse, they may be worse, than if collapse treatment had not been carried out at all. At the best the patient's life is prolonged only by the period of his stay in a sanatorium, and at the worst his chances of recovery are further jeopardised. It appears to be essential therefore that an artificial pneumothorax which does not control the disease should be abandoned as soon as it has been decided that it is ineffective, and should not be maintained in the vain hope that the collapse will eventually become satisfactory, nor should it be maintained to gratify the hopeless wish of a patient even though he has shown some initial improvement. In this connection however, it must be particularly emphasized that advantage must be taken of every available method of achieving a successful collapse in order to obtain conversion of the sputum in positive cases. Here must be mentioned the excellent results obtained by Laird in 1945. In 83% of 212 cases with an artificial pneumothorax and a positive sputum he was able to obtain a negative sputum after complete or

satisfactory collapse had been obtained with the aid of thoracoscopy and adhesion section. The production of a negative sputum should be taken as the only criterion of successful lung collapse, and every artificial pneumothorax which does not give this result should be regarded as inadequate and not without danger. This does not mean that in every case where lung collapse fails to bring about sputum conversion the patient is doomed to early death. Many patients with a positive sputum survive for a great many years, but in the main their end may be hastened by the injudicious maintenance of an ineffective pneumothorax with its attendant dangers of effusion, pyopneumothorax and spontaneous pneumothorax. This is especially true in the case of patients suffering from chronic cavitary disease.

As the late L.S.T. Burrell said <sup>22</sup> "A dry cavity in a chronic fibroid case is best treated by the same means as a chronic fibroid case without a cavity . Attempts to close the cavity by pneumothorax or thoracoplasty are usually unsuccessful and often shorten the life of a patient." It is the early exudative lesion which is most amenable to collapse therapy,

and in this connection F.H. Young <sup>23</sup> has suggested that the rapid amelioration of symptoms is probably mainly the outcome of the interference with the pulmonary circulation and the lymphatic drainage, and S. Vere Pearson <sup>24</sup> has stated that in his view



the lymphatic stasis and passive hyperaemia produced by collapse methods encourages the proliferation of connective tissue and the production of fibrosis in early lesions. These views are mentioned because too often is collapse therapy reserved for the patient with excavation and other gross lesions.

It will be appreciated that more than five years have elapsed since most of the patients in this series received active treatment, and during this period more weapons have been added to our armamentarium and recent improvements in technique have increased the value of more established methods. It is to be hoped therefore that with earlier diagnosis, earlier provision of treatment, and further improvements in the methods of treatment available for the production of adequate lung collapse, the outlook for the tuberculous patient will become increasingly favourable.

## S U M M A R Y.

1. The results are presented of an investigation into the remote results of collapse therapy in 630 patients suffering from open pulmonary tuberculosis.
2. The fatality incidence is presented, a in all cases, b in those cases wherein treatment resulted in sputum conversion, and c in those cases where treatment failed to produce sputum conversion.
3. The difference in the results obtained in the two latter groups is illustrated graphically.
4. A short review is included of the results of a few investigations of a comparable nature.
5. The incidence of complications together with the causes of death in both groups of patients 2b and 2c above is discussed and it is indicated that all cases appear to die of pulmonary tuberculosis eventually, even although the expectation of life of the negative group may be considerably prolonged.
6. The urgent necessity for early diagnosis and more especially for the provision of early treatment is discussed and a suggestion is made for this provision.

## S U M M A R Y (Contd.)

7. It is suggested that collapse therapy is valueless and may not be without danger if it is maintained after it has become evident that it will not result in sputum conversion.

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