

THE PRESENT POSITION RELATING TO CANCER OF THE LUNG*

INTRODUCTION

BY

GEORGE A. MASON

From Newcastle upon Tyne

More than 20% of men and 5% of women dying of cancer die of cancer of the lung. Each year some 400 such patients pass through our wards in the Newcastle Centre at Shotley Bridge serving a population of about three million. We see perhaps only a third or at most a half of the cases occurring in the region; only about half of these are thought worthy of admission, and of these rather less than half reach the operating table, rather more than half of these proving operable. Although there is virtually no delay in the admission of a case once the diagnosis is suspected, there has been no material improvement in this position during the last decade. This is probably the general experience, and in many quarters leads to an attitude of discouragement—if not of despair.

Faced with a large number of individual cases already too advanced for treatment when first referred, those working in this field may understandably take a far from rosy view of the problem. Many reputable physicians perhaps take the view that treatment is justified neither by the immediate nor the late results, both as regards survival and physical fitness.

Fortunately within the last two or three years, surveys from several large centres have done something to correct such impressions. Accordingly your Council felt it was desirable that a survey of the present position should be brought to the notice of the Society, and I was entrusted with this task. The simplest—and of course for me the easiest—way was to arrange this symposium, the contributors to which can all speak authoritatively on the different aspects.

Bad selection of cases and as bad surgical and clinical judgment are probably the most likely explanations of both an excessive operative

mortality and the tragic invalidism from such complications as fistulae and empyemata, which may make a hell of the few remaining months of a patient's miserable existence. Such results discredit surgery and certainly discourage physicians. Good results can be obtained, and it is hoped that to-day's symposium will guide our surgical members and encourage our physicians.

Dr. BRIAN TAYLOR reported on the Birmingham series at our Oslo meeting in 1949, and is bringing this report up-to-date this afternoon. Like ours it represents a mixed series, dealt with by several surgeons and from a particular geographical region.

Mr. VERNON THOMPSON has surveyed his own material, and will tell us of the long-term results he has achieved, using the operative procedures which he considered appropriate in individual cases, and also something of the results where secondary tumours have been removed.

Sir RUSSELL BROCK, as long ago as 1948, stressed the necessity for radical operations, entailing removal not only of the lung but of the lymphatic fields of probable cancer spread. He is here to-day to tell us of the long-term results achieved. He may well emphasize an important fact not always appreciated, namely, that an operation for removal of a cancerous lung is not just the same as removing a lung for tuberculosis or sepsis. A planned formal removal of the lung and its associated mediastinal glands "in one piece" is required.

More recently Sir CLEMENT PRICE THOMAS has described and advocated less radical procedures designed to conserve as much functioning lung tissue as possible. Of necessity long-term results are not available, but he will tell us of his experience already accumulated.

Mr. H. C. NOHL will tell us of the prognostic deductions possible from studies of the pulmonary veins and of the lymphatic glands removed at

*The Thoracic Society held a symposium on this subject in Oxford in the summer of 1959, and the following are the papers read on that occasion.

operation. It is of particular interest to me because Borrie, of Dunedin, then working in our clinic, in his Hunterian lecture in 1951 emphasized the importance of glandular invasion *vis à vis* prognosis.

Radiotherapy is widely used in the treatment of lung cancer as an adjunct to surgery or as a substitute for it in those cases where the patient or his disease is unsuitable for surgery or where this is declined. Dr. HILTON's work at University College Hospital, London, is well known to members of our Society, as she has long been specially interested in the application of radiotherapy to lung cancer, and she has kindly come to-day to tell us of her long-term results.

Dr. FEINMANN has investigated the physical and functional condition of many of our patients and will present his findings.

Finally I asked our honorary Member, Dr. O. T. CLAGETT, of the Mayo Clinic, for his views based on his well-documented experience. I shall abstract his reply, pointing out that in his opinion a variety of tumours is included in the term "bronchogenic carcinoma," differing in pathological appearance and clinical behaviour.

Dr. Clagett thinks we should consider adenocarcinoma, squamous-cell carcinoma and small and oat-cell carcinoma separately, although he recognizes atypical behaviour patterns within these groups, as well as the occurrence of "mixed" tumours. Squamous-cell tumours constitute 34%, adenocarcinoma 13%, small or oat-cell carcinoma 10%, and large cell undifferentiated (or undifferentiated squamous-cell carcinoma as some people call them) the remainder of his material.

Each type has probably a different aetiology and prognosis. The small or oat-cell cancer has a prognosis so poor that perhaps it should not be operated upon at all. On the other hand, the five-year survival rate for squamous-cell growths in the Mayo Clinic material is about 35%, for adenocarcinoma 28%, large-cell undifferentiated tumours about 25%, and there is almost no survival rate with small-cell undifferentiated growths. He believes that squamous-cell growths merit a radical lymph node dissection, as they tend to metastasize in the glands, and a fairly radical

approach. Lobectomy is not of much use with these, as he has found local recurrence in the bronchial stump common. Other types tend to be blood-borne rather than lymphatic, and more conservative resections suffice. As he reported in *Thorax* two years ago, the incidence of vascular involvement is high in the more peripheral adenocarcinomas and large-cell cancers.

Finally he said, "Please greet all my friends in the Thoracic Society at the meeting in Oxford. I wish I could be there." I am sure we all reciprocate this wish and congratulate Dr. Clagett on his results.

Time only permits a brief reference to our Newcastle material.

Dr. Ross, who has on two occasions in recent years presented surveys of the results of radiological treatment in our region to this Society, culled a list from the Regional Cancer Registry of 84 of our patients first seen between 1946 and 1954, who were known to have lived for five years or more after resection. Working back from these, Mr. HAROLD BASSETT, my senior registrar, found that this represents a survival rate of about 4% of the 2,000 patients admitted during those nine years, or 10% of those explored, or 20% of those in whom resection proved possible. If the survey is limited to the six years 1949-54 the five-year survival rate for resection cases is 23% and for the year 1952 alone it is actually 31%. These approximate figures, uncorrected for life expectancy, represent the percentage survival of those subjected to resection and include those dying in hospital after operation. In view of Dr. Clagett's figures, Mr. Bassett looked up our 1953-54 cases and found that there were 83 pneumonectomies with a mortality rate of 7.2% and a five-year survival rate of 20.5%, and 13 lobectomies with a mortality rate of 7.7% and a five-year survival rate of 46%. Looked at from the histological angle, he found that the five-year survival rate for squamous-cell cancer (55 cases) was 25%, for adenocarcinoma (seven cases) 28%, for alveolar cancer and adenomatosis conditions (six cases) 28%, and for undifferentiated cancers (22 cases) 16%. Unfortunately it has not been possible to break the last group up into large- and small-cell varieties.

RESULTS OF SURGICAL RESECTION

BY

A. BRIAN TAYLOR

From the United Birmingham Hospitals

The Cancer Follow-up Department of the United Birmingham Hospitals has records of 8,002 cases of lung cancer between 1939 and 1957. Most of these cases were seen at the hospitals of the Group, but during the later years other hospitals in the Birmingham Region participated. All except five patients (alive when last seen) have been traced till 1958 or death before that year. The second annual report of the department (1954) records most of the details of these cases up to 1952, but here the results of surgical treatment are brought up to the end of 1958.

For the purpose of estimating prognosis, the detailed study of the 4,054 cases occurring between 1947 and 1954 has been used, giving at least five years' possible survival. The introduction of resection as an effective treatment began in 1937, but until the end of the war full facilities were not really available.

The resection rate is the number of cases treated by radical resection, excluding palliative (incomplete) operations. It includes lobectomy and pneumonectomy, the former having been intro-

duced more recently as reports of its efficacy appeared. The decision for which operation to choose has been mainly an anatomical one. Fig. 1 shows the increasing numbers of cases encountered and the increasing rate of resection. (The 1955 records have not been completed for analysis owing to an internal change of methods.) In summary:

From 1939 to 1946 there were 23 resections from	887 cases =	2.6%
" 1947 " 1954 " " 678 " "	4,054 " =	16.7%
" In 1956 " " 228 " "	952 " =	23.9%

The ages of all the cases lay between 15 and 89 years, and for resection between 24 and 74 years.

The side of resection was recorded in 669 cases: it was the right in 342 and left in 327, i.e., the right in 51.1%.

The sex of the 2,985 patients seen between 1950 and 1954 was: male, 2,674; and female, 311 (ratio male to female 8.6 to 1). Of these cases, 561 had resections performed: male, 519; female, 42 (ratio of male to female 12.4 to 1).

RESULTS

Follow-up has extended to the end of 1958 and Table I shows the percentage of patients alive at this time. Of 4,054 patients, 678 had a resection and 21.7% were alive at the end of 1958. Fig. 2

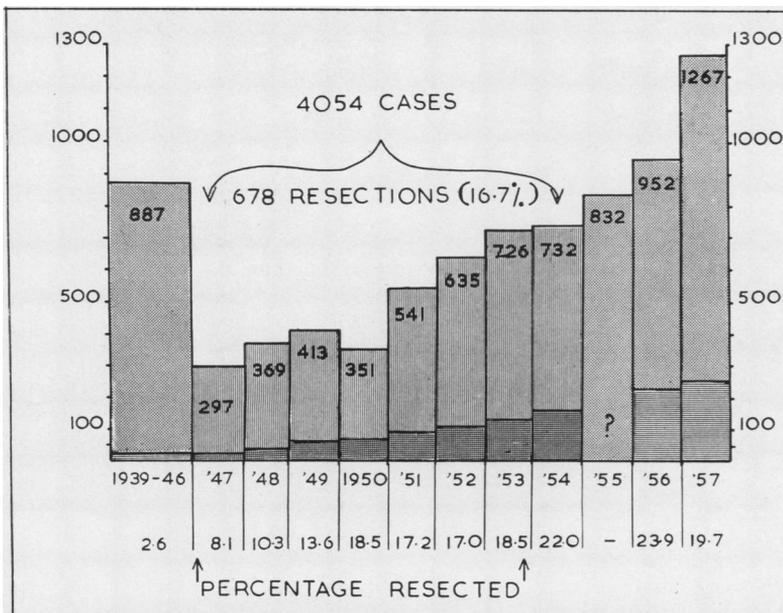


FIG. 1.—Number of cases of bronchial carcinoma per year with numbers resected (dark hatching).

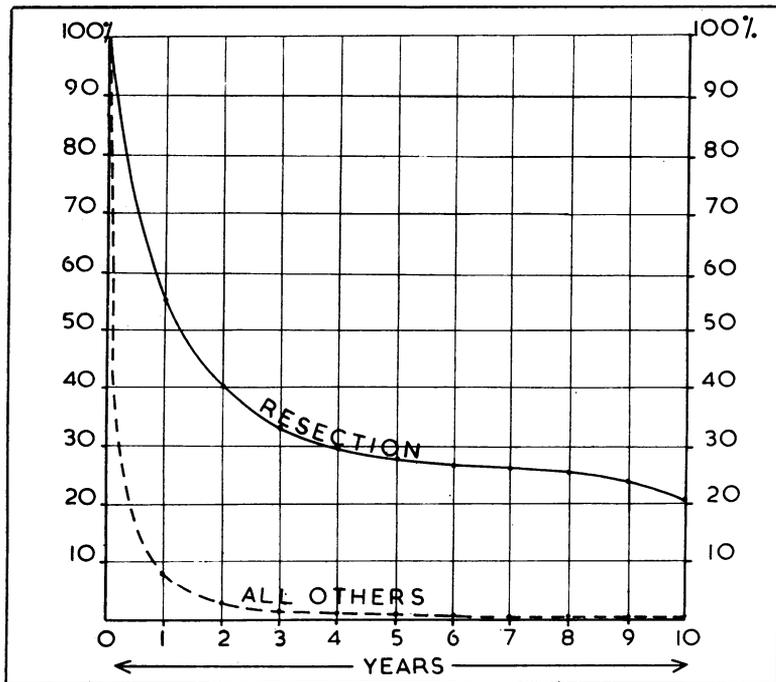


FIG. 2.—Percentage survival from bronchial carcinoma with and without resection, corrected for age expectancy.

shows these figures graphically with a correction for age expectancy, i.e., excluding deaths from all other causes at the age at risk. In our earlier report (1954) it was shown that without treatment the expectation of life at diagnosis was 4.4 months on average, and from these figures it will be seen that without resection 91.6% were dead in 12 months and 97.4% in 24 months, one patient treated by deep x rays being alive after 10 years, whereas a successful resection keeps 28.9% alive up to five years, and 21.4% (11 out of 61 resections) alive up to 10 years.

TABLE I
PERCENTAGE OF CASES STILL ALIVE IN 1958 AFTER RESECTION FOR LUNG CANCER 1947-1954

Year	Resection	Still Alive (%)
1947	23	4.4
1948	38	21.1
1949	56	23.2
1950	65	23.1
1951	93	22.6
1952	108	22.2
1953	134	21.6
1954	161	22.4
1947-54	678	21.7

The causes of death after resection for 678 operations between 1947 and 1954 are analysed in Table II. The operative mortality is death

TABLE II
CAUSE OF DEATH AFTER RESECTION FOR CARCINOMA OF BRONCHUS

Year	Resection	Total Deaths	Operation (One Month) (%)	Recurrence (%)	Other Causes (%)
1947	23	22	13.0	69.6	13.0
1948	38	30	21.1	44.7	13.1
1949	56	43	21.5	46.4	8.9
1950	65	50	12.3	55.4	9.2
1951	93	72	18.3	55.9	3.2
1952	108	84	13.0	60.2	4.6
1953	134	105	9.7	60.4	10.5
1954	161	125	11.2	65.2	1.2
1947-54	678	531	13.7	58.7	5.9

within one month of operation and has improved a little over the eight years to 13.7%. In 1957 there have been 250 resections and the operative mortality is now 8.4% (21 deaths).

I have to acknowledge with gratitude the excellence of the follow-up service under the direction of Miss Levi, and its notable completeness makes assessment of the results reliable. I am grateful to Dr. Waterhouse for his help with the compilation and analysis of the figures. Most of the hard work was done by the surgeons, in particular Mr. A. L. d'Abreu and Mr. J. Leigh Collis. I am much indebted to them and for their permission to use the figures.

REFERENCE

United Birmingham Hospitals (1954). *Annual Cancer Report 2*.

RESULTS OF RESECTION

BY

VERNON C. THOMPSON

I propose to give you the results of my own personal operations for carcinoma of the lung in the 15-year period 1941 to 1956. The operations have been carried out in various hospitals, but most of them since the war have been at the London Hospital or the London Chest Hospital. My policy throughout the whole period remained unchanged. If I formed the opinion that operation could offer the patient relief of symptoms, even if there was no prospect of cure, operation was undertaken. If the growth could be removed by lobectomy that was my choice. When lobectomy was not a practical proposition for technical reasons, I removed the whole lung. I cannot claim that I have done what is termed a "radical" operation. Some resections have been more extensive than others, and an effort has been made to remove the area of lymphatic drainage with the part resected, but the anatomy of the lymph drainage of the lobes of the lung often makes true radical resection a practical impossibility. I have not opened the pericardium as a routine, but I have done this in 22% of the pneumonectomies when it was necessary for technical reasons.

The total number of operations was 399. Ninety-one cases were found to be inoperable, giving a resection rate of 77%. Pneumonectomy was performed on 220 patients and lobectomy on 88. The total operative mortality of resection was 5.8% ; for pneumonectomy 6.8%, for lobectomy 3.4% (Table I).

TABLE I

399 OPERATIONS FOR CARCINOMA OF LUNG DURING 1941-56

Inoperable	91
Pneumonectomy	220
Lobectomy	88
Operability	77%

OPERATIVE MORTALITY OF RESECTION (DEATHS IN HOSPITAL)
308 cases .. 18 deaths (mortality 5.8%) pneumonectomy 6.8% and lobectomy 3.4%

Table II gives some indication of the type of patient accepted for surgery. Twenty-eight per cent. were over the age of 60, five patients were over 70, and the oldest was 75.

In the years before the advent of penicillin, there was a very high complication rate and a high operative mortality. From 1941 to 1945, I performed 28 pneumonectomies and only one patient was over 60 years of age, but the operative

TABLE II
AGE OF SERIES OPERATED ON FROM 1941 TO 1956

Youngest	24 years
Oldest	75 "
86 patients over 60	28%
Pneumonectomy 48 (22.2%)	Lobectomy 38 (43%)
40 patients over 65	10%
Pneumonectomy 16 (7.3%)	Lobectomy 14 (16%)
5 patients over 70	1.6%
Pneumonectomy 2 (0.9%)	Lobectomy 3 (3.4%)

mortality was 28%, and the incidence of bronchial fistula was 48% (Table III). The cause of morbidity and mortality was mainly sepsis.

TABLE III
OPERATIVE MORTALITY IN PNEUMONECTOMY 1941-45

Case No.	Sex	Age	Cause of Death	Survival Time
1	Male	45	Fistula, empyema and pericarditis	19 days
2	"	59	Shock and anoxia	2 hours
3	"	35	Fistula, sepsis, pneumonia, pericarditis	16 days
4	"	55	Fistula, empyema, pneumonia, metastases	2 months
5	"	61	Fistula, pneumonia	6 weeks
6	"	58	"	5 "
7	Female	43	Streptococcal pneumonia	13 days
8	Male	51	Pulmonary embolism	10 "

Before routine use of penicillin, and muscle graft for closure of bronchus.

From the beginning of 1945 I adopted a standard technique to which I have adhered ever since. Anaesthesia was carried out with endo-bronchial blockage to prevent spill-over infection. The bronchus, after closure with interrupted thread sutures, was covered by a hinged graft of intercostal muscle. Antibiotic cover was employed in all cases.

TABLE IV
OPERATIVE MORTALITY 1945-56

Case No.	Sex	Age	Cause of Death	Survival Time
<i>Pneumonectomy</i>				
1	Male	57	Patchy collapse, heart failure	4 days
2	"	64	Heart failure	18 "
3	"	55	Haemorrhage	5 hours
4	"	52	Dyspnoea, heart failure	6 weeks
5	Female	57	Patchy collapse, heart failure	2 days
6	Male	46	Coma, anoxia	24 "
7	"	50	Pulmonary embolism	10 "
<i>Lobectomy</i>				
1	Male	65	Bronchial fistula, pneumonia	14 days
2	"	68	Cerebral thrombosis, pneumonia	3 weeks
3	Female	61	Shock and anoxia	6 hours

In the 280 cases there was an incidence of six bronchial fistulae (three temporary) 2.1%.

There was an immediate and striking improvement in the results. From 1945 to 1956, I performed 192 pneumonectomies with an operative mortality of 3.6% (seven deaths) and

88 lobectomies with a mortality of 3.4% (three deaths). In this series of 280 cases there were six bronchial fistulae, three of which were temporary and closed spontaneously (Table IV). There were no post-operative deaths in the last 158 cases in this series.

LATE RESULTS

The follow-up of these patients has been very comprehensive, but over the years some have been lost; all these are counted as dead.

There is a striking difference in the prognosis between those patients in whom the growth remained confined to the lung and those in whom the growth had extended beyond the lung at the time of operation. Extension beyond the lung may be by direct spread, by lymphatic spread to the mediastinal lymph nodes, or by metastasis elsewhere.

For the purpose of this communication all cases in which the growth had extended beyond the lung at the time of operation are grouped together. The three-year survival rate is shown in Table V.

TABLE V
THREE-YEAR POST-OPERATIVE SURVIVAL 1941-56
308 resections—107 survivors—34.8%.

	Cases	Survivors
<i>Pneumonectomy</i>		
Total	220	60 (27.3%)
With extension .. .	151	27 (17.9%)
Without extension ..	69	33 (48%)
<i>Lobectomy</i>		
Total	88	47 (53.4%)
With extension .. .	31	10 (32.2%)
Without extension ..	57	37 (65%)

The fact that the survival rate is better after lobectomy than after pneumonectomy is merely an indication that lobectomy can be employed in more favourable cases. A three-year survival rate of 65% after lobectomy when the growth is confined to one lobe should be a spur to early diagnosis. Survival rate of only 17.9% after pneumonectomy when the growth has extended beyond the lung is an indication of the limitations of surgery in this condition.

Table VI shows the long-term survival rate up to 10 years; beyond this the figures are not significant. There have been no deaths from

TABLE VI
LONG-TERM POST-OPERATIVE SURVIVAL 1941-56

Survival Time	Resections	Survivors	Percentage
3 years	308	107	34.8 { Pneumonectomy 27.3 Lobectomy 53.4
5 ..	256	69	27.3 { Pneumonectomy 21.7 Lobectomy 40
10 ..	120	20	16.6 { Pneumonectomy 13.3 Lobectomy 30.4

metastases after 10 years. In this series there are four patients who have survived 17 years. Even after five years deaths from metastases are considerably outnumbered by deaths from other causes. In the group that survived more than five and less than 10 years, we lost trace of six; four died of metastases; seven died of heart failure; and three developed a fresh primary carcinoma of the lung.

There are a few other interesting points that arise from this investigation. There were nine patients in whom the growth involved the ribs radiologically. In these a part of the chest wall was removed *en bloc* with the lobe or lung. Six have survived for more than three years, one for eight years, one for six, two for four, and two for three years. Although involvement of the chest wall is regarded by some as a contraindication to surgery, I have found the prognosis by no means unfavourable. Surgery should be undertaken even if it is thought that it is only palliative in these cases.

Four patients in this series have had resections after a cerebral metastasis had been removed by a neurosurgeon. One is alive and well after 11 years, one survived for two years, and two for one year.

Two patients in the series have been treated by segmental resection; one has just retired from work after 11 years, the other has survived five years and is now 80 years old.

Some of these bizarre results lead me to the conclusion that the surgeon can take credit only for diagnosing and removing the lesion without endangering the life of the patient. The long-term result really depends on the stage of the diagnosis and the patient's natural defences against his own particular growth.

RADICAL PNEUMONECTOMY

BY

Sir RUSSELL BROCK

It is necessary first to describe briefly what is meant by radical pneumonectomy.

Pneumonectomy as ordinarily practised might well be thought a radical procedure in itself, seeing that a whole lung is removed. The classical cancer operations, however, demand removal of the affected viscus together with its fascial connexions and as much of the associated lymphatic field as possible. As applied to the lung this includes removal of the anterior and posterior mediastinal fatty tissue and lymph nodes, clearance of the right and left tracheo-bronchial group of nodes, and also most of the inferior tracheobronchial group. In addition, and very important, is avoidance of disturbing the hilar structures by routinely securing the vessels within the pericardium and excising an area of pericardium which protects the hilar compartments. This is not the time or place to describe the operation fully, but details are available in the original description of it (Brock and Whytehead, 1955).

One objection made to the operation is that it is not really radical. While one appreciates that it is not possible to perform a complete clearance of all the wide lymphatic field potentially involved (including that of the opposite side), the operation is as radical as is possible having regard to the limitations of anatomy and of the tolerance of the human frame and is no less radical than other similar procedures for cancer elsewhere. I used to call the operation "block dissection pneumonectomy," but altered it to "radical pneumonectomy" in conformity with the usual nomenclature of cancer surgery.

Whether the operation is truly radical or not it is certain that unless the technique described is used it is inevitable that many otherwise removable growths will be left behind. It is true that in this way one may on occasion remove what is really an inoperable condition, but I happen to believe that in dealing with such a terrible condition as cancer of the lung one must be prepared to be aggressive if one is to help the patient to the full. Moreover, there is something that can never emerge from the bare recital of statistics, and that is the lessons learned from individual cases. I can think of many patients who have had their life saved by radical pneumonectomy, whereas no lesser operation could have been usefully used.

I will mention only my first patient operated on 12 years ago, in 1947. A huge mass of growth

occupied the right upper lobe and also the right tracheobronchial group of lymph nodes. The radical clearance involved division of the vagus and phrenic nerves at the superior thoracic inlet and block removal of all mediastinal and lymph node tissue below. This patient is still alive and well 12 years after. No lesser operation could have saved him.

RADICAL VERSUS CONSERVATIVE RESECTION

For several years now I have felt on the defensive in relation to radical pneumonectomy. I used to resent this, but accept it more patiently now. I find that many people believe that my routine operation for lung cancer is a radical resection. I think that I have sufficient surgical intelligence and restraint to act otherwise. Cancer of the lung occurs in different forms, with differing grades of malignancy, and often the less severe forms are related to greater age and frailty. I exercise my knowledge and intelligence to perform a lesser operation when I think this is indicated. You may find confirmation of this in the fact that my own series of cases on which this article is based consists of:

Radical pneumonectomy	...	...	90	cases
Simple pneumonectomy	...	...	83	..
Lobectomy	...	...	55	..

From this it will be observed that I employ variety.

There has been a big change in the pattern of my surgery during recent years, and I have been performing fewer operations for lung cancer myself. I am now presenting only those cases operated on personally; this has one advantage in that the overall follow-up is long.

It is the fashion to plead for so-called conservative resection in lung cancer. In common with other surgeons I welcome and support any procedure that will combine removal of the growth with conservation of functioning lung tissue. It is repellent to me to have to excise a nice piece of healthy lung which could with advantage have been left with the patient. I strongly support any rational conservative operation of this type.

I feel, however, that on many occasions surgeons lose their judgment in this matter and by making a fetish of conservatism endanger the chance of their patient obtaining lasting relief or cure.

At a recent visit to a thoracic surgical centre one of the operations on the list was "lower lobectomy for carcinoma of the lung." Now this showed that the surgeon had prejudged the issue. Knowing that it is an advantage functionally for

a patient to keep an upper lobe rather than to lose it, he was setting out to do lobectomy come what may. The radiographs seemed to show a condition either inoperable, or near inoperable, even by pneumonectomy. The chest was opened and the lower lobe was attacked. Eventually removal was abandoned and the chest was closed.

This illustrates how totally wrong we can get in our thoughts. Our first task with this dreadful disease should be to aim at curing our patient, and this can best be done by removing the growth as radically as possible. If this can be achieved by conservation of lung tissue, then it has my full support. But when a surgeon sets out to apply a weak policy of conservatism routinely, then I cannot accept it as in the interest of the patient. Cancer of the lung is not a standard disease, and we should decide what type of operation to do when we survey each individual problem.

For example, if I have an elderly patient with a well-localized tumour within a lobe, of course I do not do a radical pneumonectomy. By contrast, if I have a patient of middle age with a tumour affecting a large bronchus, I believe that, in general, I give him a greater chance of cure or of long freedom from recurrence by a radical operation. To a man below the age of 55 the chance of lasting cure is of paramount importance and should not be jeopardized by an incomplete operation. It can be argued that it is quite wrong not to give him the greater chance of cure that a wider clearance confers. This seems to me self-evident and in keeping with all our knowledge of cancer anywhere in the body.

An objection has been made that the radical operation carries a higher mortality. That this is just not true will emerge from results to be shown.

Whether the best operation for lung cancer is a radical or a conservative one cannot yet be decided. It is a good thing for surgery that different surgeons use different types of operation, for only by comparing our separate results can we hope to learn.

RESULTS

Table I shows my radical cases operated on between 1947 and 1959.

TABLE I
RADICAL PNEUMONECTOMY

Total	96
Died	11 (12%)
since	47
Still alive	32 (40%)

Table II shows the chief survival rates in the 79 survivors.

TABLE II
SURVIVAL MORE THAN FIVE YEARS AFTER
RADICAL PNEUMONECTOMY

Over 12 years	1
11	2
10	9 (11%)
9	14
8	15
7	22
6	24
5	31 (40%)

It should be noted that 40% of the survivors are alive after five years. This compares with the figures of Gifford and Waddington (1957) in which the five-year survival rate was 28%, and of Bignall and Moon (1955) in which it was 33%. Moreover, I know of no pneumonectomy figures in the world literature which show a five-year survival rate over 33%. It is common to find the five-year survival rate after lobectomy to be much higher, e.g., 40 to 50%, as indeed is shown in my own series (Table III), but lobectomy cases are essentially a selected group and can never be comparable with a group of pneumonectomy cases whether radical or sub-radical.

It is desirable to compare my results with radical pneumonectomy with my results in simple pneumonectomy and with lobectomy. These are shown in Table III.

TABLE III
COMPARATIVE FIGURES

	Total	Mortality (%)	Five-year Survival (%)	Still Alive (%)
Lobectomy	54	4	44	49
Simple pneumonectomy	83	21.6	30	20
Radical pneumonectomy	90	12	40	40

These figures may be statistically weak, but they go far to suggest that a policy of performing radical pneumonectomy whenever indicated is justified by the improved results.

The object of the radical operation is to try to catch in the wider surgical net lymph nodes that are invaded with growth and which would not otherwise be left. Some indication of what is achieved is given in Table IV.

TABLE IV
79 SURVIVORS AFTER RADICAL PNEUMONECTOMY

	Glands Involved	Glands Not Involved
Total	39	40
Alive now	8	23
Dead	32	17
Survival over five years	7	24

(Continued at foot of next page)

LOBECTOMY WITH SLEEVE RESECTION

BY

Sir CLEMENT PRICE THOMAS

London

Theoretically the best operation for carcinoma of the lung should aim at the removal of the affected organ with its lymphatic drainage area, as far as is practicable; in other words, a pneumonectomy, a procedure which, to say the least of it, is not routinely applicable. The chief objections to pneumonectomy as a routine procedure are, first, that the patient's cardio-respiratory reserve may be such that the result of such an operation would so reduce his respiratory capacity that he would be unable to lead a reasonably useful life. The second objection is more debatable, and, unfortunately, what is only a personal impression is not yet statistically proven. I have been impressed by the fact that patients for whom a pneumonectomy has been satisfactorily performed are no more incomed during the first two to three years than those who have had a lobectomy. After this time, however, the patient begins to suffer more and more from respiratory embarrassment, and eight to 10 years after the operation a large percentage of them suffer from cor pulmonale, and again I am equally impressed by the fact that this sequence of events seems to occur but rarely in patients who have had a lobectomy.

Taking into consideration the above factors, it seems reasonable to conserve as much pulmonary tissue as possible, provided that, by doing so, the

patient's expectation of survival is not materially altered as compared with that following the more extensive procedure. There can be no gainsaying the great advantage of lobectomy over pneumonectomy in the immediate post-operative period, in that the physiological upset is less and the morbidity and mortality are likewise considerably reduced.

The aim and object of this communication are, by analysing a series of cases that have been personally operated upon, to try to show that the prognosis after lobectomy and lobectomy associated with sleeve resection of the main bronchus is not materially altered from that of those patients who have been submitted to pneumonectomy. It is, of course, understood that pneumonectomy must be the operation of choice in a percentage of cases, as being the only operation by which the growth can be removed adequately; also that a lesser procedure such as lobectomy can only be done in selected cases, where the conditions make it feasible.

Standard lobectomy can be carried out when the tumour is of the circumscribed type and is confined to the affected lobe; also when a growth of the endobronchial type is so situated that the macroscopic edge of the growth is at least 1 cm. from the line of bronchial section; the latter is the case in tumours affecting the lower and middle lobe bronchi on the right side, and on the left side when the growth is well within the lumen of the lower lobe bronchus below the apical lower orifice; in this way, one can be reasonably sure that the line of bronchial section will be through healthy tissue.

When the tumour is situated in the upper lobe bronchus or its segmental orifices, or at the orifice of the lower lobe on the left side, then it is not possible to place the line of bronchial section sufficiently far from the edge of the growth. In these circumstances, a sleeve of the main bronchus must be taken as well, and in upper lobe cases the lobe and main bronchus are resected, with subsequent anastomoses between the lower end of the main bronchus and the upper end of the bronchus at tracheal level; in the case of the lower lobe, this with the main bronchus is resected, after transection of the upper lobe bronchus, which is ultimately anastomosed with the upper end of the main bronchus. In certain cases it may be necessary to remove either a portion of or a whole segment of the pulmonary artery, especially on the left side, in order to complete the operation. The technique has been described elsewhere and the only question at issue is as to whether or not the results justify the procedure.

(Continued from preceding page)

You will note that in seven patients who survived over five years the excised nodes were involved with growth. Without a radical operation they would not have been cured.

It would be very satisfactory if the post-mortem findings could be given in all cases so as to compare the incidence of local recurrence with those patients in whom a radical clearance had not been used. Unfortunately it has not been possible in most cases to obtain a necropsy.

I suggest, however, that the low mortality and high rate of long-term freedom from recurrence indicate that we cannot afford to dismiss radical pneumonectomy from our methods of treatment of cancer of the lung.

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TABLE I

Submitted to operation ..	826			
Resections ..	582	Early deaths ..	84 (14%)	
Operable cases ..	419	" "	49 (11%)	
Resectable cases ..	163	" "	35 (21%)	
Thoracotomies ..	244	" "	30 (12%)	(29%)

This table represents a personal series of all the patients submitted to operation since 1935, and gives the background against which the tables which follow may be judged. The only points to note are that just over 70% of the cases submitted to operation had resections, the overall early death rate being 14%. Under "early death" are included all those patients who have been unable to leave hospital and die there, irrespective of the length of time which has elapsed between the operation and their demise. The early mortality of the resectable group is almost twice that of the operable group; incidentally, the term "resectable" is reserved for those cases in which some structure which has been invaded by the growth has been resected, other than the lung or part of it, such as pericardium, atrial wall, chest wall, diaphragm, oesophageal wall, or superior vena cava, and as "operable" those cases in which resection is limited to pulmonary tissue, with, of course, the lymphatics, the latter being dealt with almost as completely as is done during a pneumonectomy.

TABLE II

PATIENTS SUBMITTED TO RESECTION BETWEEN 1935 AND 1953 (INCLUSIVE)

Resections ..	279	Early deaths ..	44 (16%)
Operable cases ..	219	" "	25 (11%)
Resectable cases ..	60	" "	18 (30%)
Operable five-year survivals	73	(33%)	{ Alive .. 53 { Dead .. 20
Resectable ..	7	(11.6%)	
Five-year survivals of whole group ..	80	(28%)	3

These figures are self-explanatory. The striking figure, however, is the five-year survival rate for the resectable group. It perhaps should be pointed out that these figures are calculated on the total group, including the early deaths, and that if the early deaths are excluded, then the survival rate naturally increases and is as follows: Operable cases, 37.4%; resectable cases, 16.6%; and for the whole group, 34%.

TABLE III

TYPES OF RESECTION AND FIVE-YEAR SURVIVAL RATES 1935-53

Pneumonectomies ..	246	Early deaths ..	41 (17%)
Five-year survivals ..	66	(27%)	
Lobectomies ..	33	Early deaths ..	2 (6%)
Five-year survivals ..	14	(39%)	

The ratio between lobectomies and pneumonectomies is very small in comparison with later figures, and the five-year survival rate for lobectomy, as compared with that for pneumonectomy, obviously indicates a careful selection of cases for the former procedure.

TABLE IV

STANDARD LOBECTOMIES BETWEEN 1954 AND 1958 (INCLUSIVE)

No. of cases	Deaths		
	early deaths	late	
126	52	12 (9.5%)	
Operable ..	106	39	10 (9.4%)
Resectable ..	20	13	2 (10%)
			11

Of these patients, the survivals for two, three, and four years were as follows:

For 2 years ..	23 (40%)	out of a total of 57
" 3 ..	15 (40%)	37
" 4 ..	4 (26%)	15

The five-year survival rate of this group could not be stated, but in any case the figures, as with the above, are so small as to be of no statistical value; the percentages are put in merely for ease of comparison with the later table. From these figures, however, it will be appreciated that the indications for operation have been considerably enlarged as shown by the number of resectable cases included in the series compared with the earlier group in which only one case in the 33 was in the resectable group. These figures, however, support the thesis that lobectomy is a justifiable procedure where it is practicable.

TABLE V

LOBECTOMY WITH SLEEVE RESECTION

No. of cases	Deaths		
	early deaths	late	
36	13	3 (8.3%)	
Operable ..	33	11	3 (9%)
Resectable ..	3	2	0
			2

Of these patients, the survivals for two, three, and four years were as follows:

For 2 years ..	13 (60.5%)	out of a total of 20
" 3 ..	4	6
" 4 ..	2	6

Both groups are so small that really no conclusion can be sought from them except perhaps to state that a reasonable comparison can be made between sleeve resection and standard lobectomy, and that probably there is little to choose between them as far as ultimate prognosis is concerned.

When comparing these figures with those for pneumonectomy, it must be clear that the former

group is a strictly selected one compared with the latter. The proportion of resectable cases submitted to the two procedures is an index of the degree of selection; for pneumonectomy the ratio of operable to resectable cases is slightly over 2 to 1, whereas for lobectomy of both kinds it is about 7 to 1.

There is no question that many cases at the present time, probably the majority, must, of necessity, be treated by pneumonectomy, but there can be no doubt that many cases can be treated by lobectomy with advantage to the patient, not only in the pre-operative period, but also in the long term, not only from the point of view of the ultimate prognosis for the disease, but also from the point of view of the cardiorespiratory reserve. It also seems reasonable to suggest that the operation of resection of a sleeve of the main bronchus in conjunction with lobectomy appears to give as satisfactory results as standard lobectomy, while at the same time it enlarges the indications for lobectomy considerably. In association with two junior colleagues, more than 120 patients have been so treated with mortality and survival rates comparable with those quoted above, and, until some more satisfactory method of treating cancer is evolved than by surgery, it seems likely that sleeve resection with lobectomy will have its place.

A THREE-YEAR FOLLOW-UP OF CLASSIFIED CASES OF BRONCHOGENIC CARCINOMA AFTER RESECTION

BY

H. C. NOHL

From the London Chest Hospital

Four years ago I had the honour to speak to this society on the results of 50 dissections of lungs resected for carcinoma of the bronchus. An enlarged version of this paper appeared in *Thorax* (Nohl, 1956). At that time the various histological types were analysed with the aid of a classification. This scheme registers (a) the extent of the growth, (b) the degree of lymph node involvement, and (c) the presence or absence of major pulmonary vein infiltration.

This classification was originally proposed by Salzer (1951) and was modified at the London Chest Hospital as shown in Table I.

TABLE I
SALZER'S CLASSIFICATION OF CARCINOMA OF THE
BRONCHUS
(As modified by the London Chest Hospital)

<i>Extent of Growth</i>	
"A" cases	.. Growth confined to the lung.
"B" ..	.. The tumour has reached the visceral pleura. This includes cases in which a growth crosses a fissure from one lobe to another.
"C" ..	.. Growth has infiltrated by continuity the neighbouring structures, e.g., parietal pleura, chest wall, oesophagus, etc.
<i>Lymph Node Involvement</i>	
Stage 0	= no lymphatic metastases.
.. 1	= infiltration of the intersegmental nodes.
.. 2	= the interlobar or the hilar nodes are metastasized.
.. 3	= the mediastinal nodes show invasion.
.. 4	= distal metastases are present, e.g., supraclavicular nodes, liver metastases, etc.
<i>Vascular Involvement</i>	
"V" cases	.. There is demonstrable invasion of the intima of the pulmonary veins.

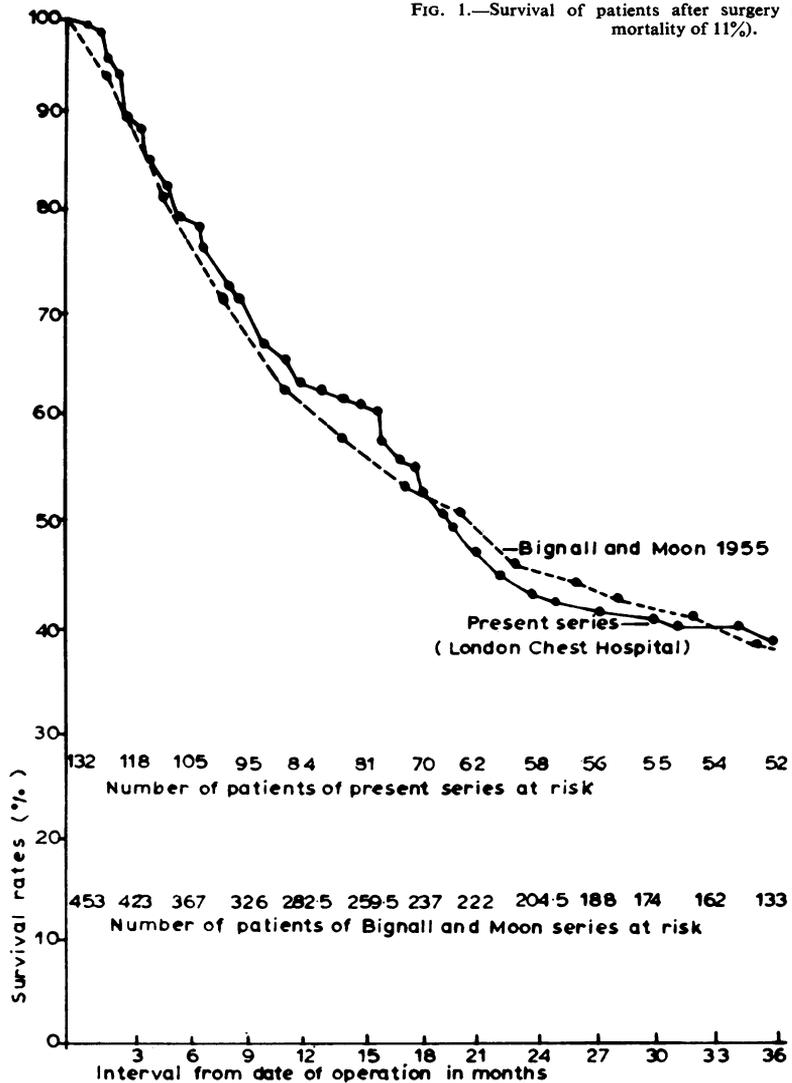
Although well over 200 lungs have since then been dissected and classified, it is only possible to give a three-year follow-up of the first 132 patients, as the remainder were operated on too recently.

TABLE II
EXTENT OF PRIMARY TUMOUR RELATED TO LYMPH
NODE METASTASES AND VENOUS INVOLVEMENT IN
211 CASES*

Extent	Total	Node Metastases		Venous Involvement	
		Number	Percentage	Number	Percentage
Group "A"†	77	51	(66%)	15	(19%)
.. "B"	83	56	(67%)	26	(31%)
.. "C"	51	42	(82%)	32	(63%)

* Modified from Bignall, J. R., *Carcinoma of the Lung*, pp. 134 and 138.

† Group "A" = tumour limited to the lung. Group "B" = tumour invading the pleura. Group "C" = tumour invading the mediastinum or chest wall.



Of these, 87 had pneumonectomies and 45 lobectomies. Therefore one-third of the patients did not have a whole lung removed. To show that these make up a representative sample their survival rates are compared with the much larger series of Bignall and Moon (1955) (Fig. 1). The similarity of the two curves is striking.

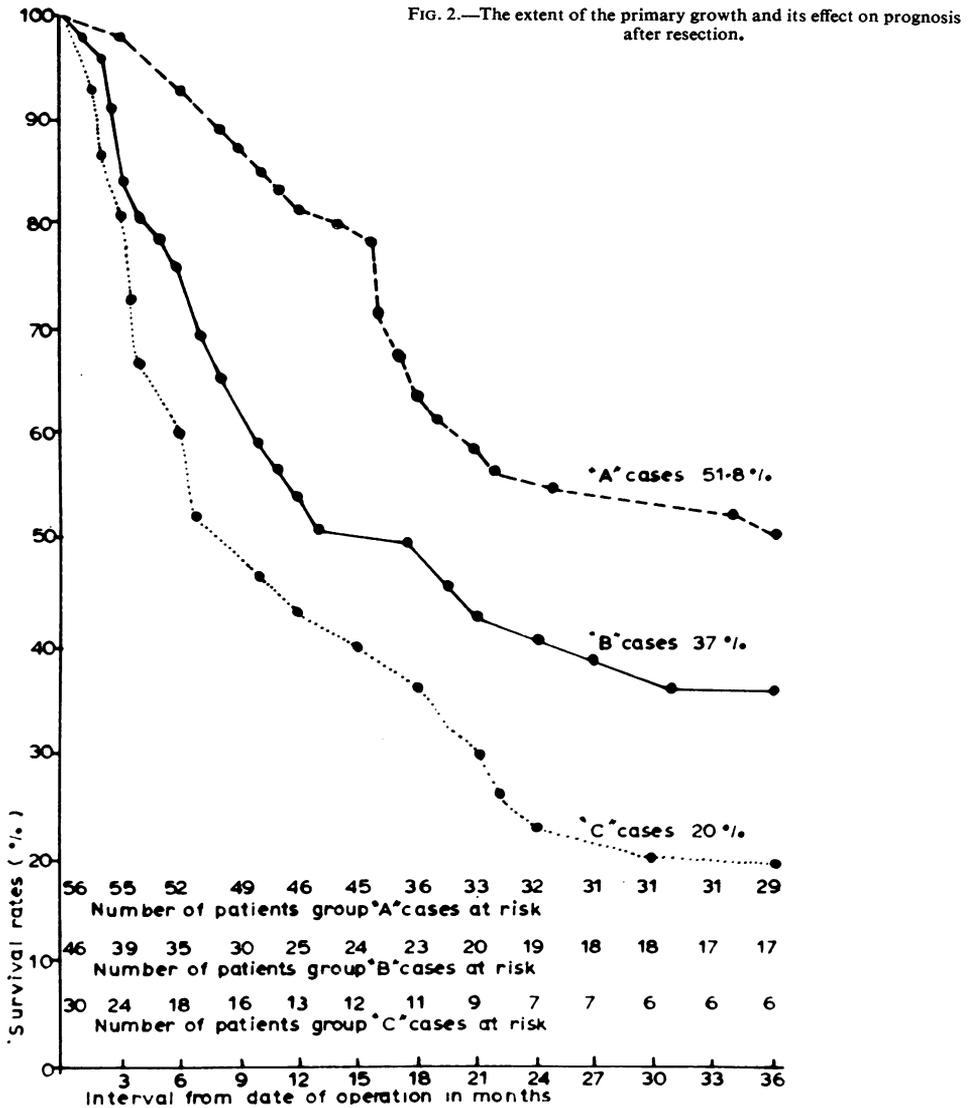
EXTENT OF THE GROWTH

Fig. 2 shows how the extent of the growth determines the chances of survival after resection. An explanation for this marked difference in survival rates between the three classes is to be

found in Table II. This shows that as the extent of the growth becomes greater the incidence of lymph node involvement and the pulmonary vein infiltration increases correspondingly.

INVOLVEMENT OF LYMPH NODES

The influence of the degree of lymph node involvement on the chances of survival is demonstrated in Fig. 3. It is noteworthy to find that after three years the percentage of stage-2 survivors is as high as those in stage 0-1. These findings must be interpreted as follows: Resections, whether they are lobectomies or

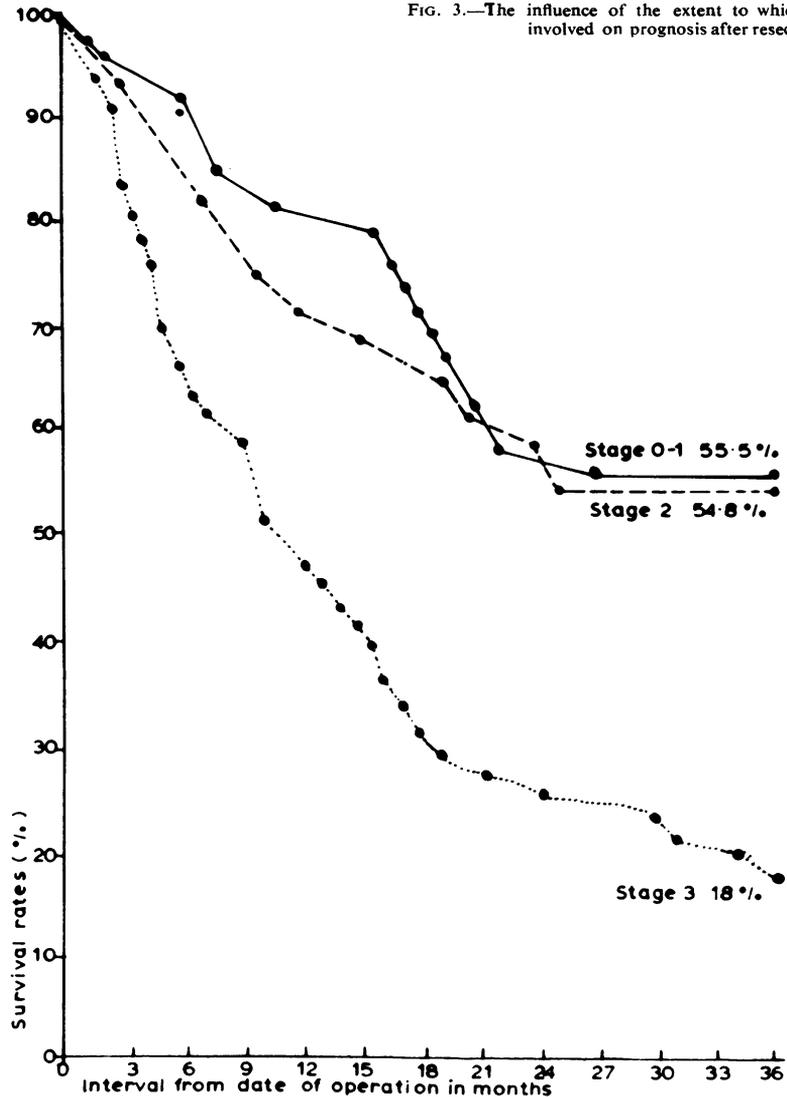


pneumonectomies, can cope relatively adequately with stages 0-2, but once stage 3 has been reached resection can no longer deal effectively with the lymphatic spread. It is very doubtful whether a "radical pneumonectomy" can achieve any better results. After all, the subcarinal, the paratracheal, or the para-oesophageal nodes, that constitute the mediastinal lymph nodes, can only be picked off the various mediastinal structures, and this is not what one normally understands by radical cancer surgery.

PULMONARY VEIN INFILTRATION

We have investigated this problem by two methods. At first during the lung dissections we used to open the pulmonary veins along their course and prepare sections if definite thrombosis or roughness of the intima in the region of the growth were found. Each case was then classified according to the above scheme. Later we used an entirely different method by injecting the veins with a bismuth-gelatine mixture and thus were able to identify the smallest veins. With the latter

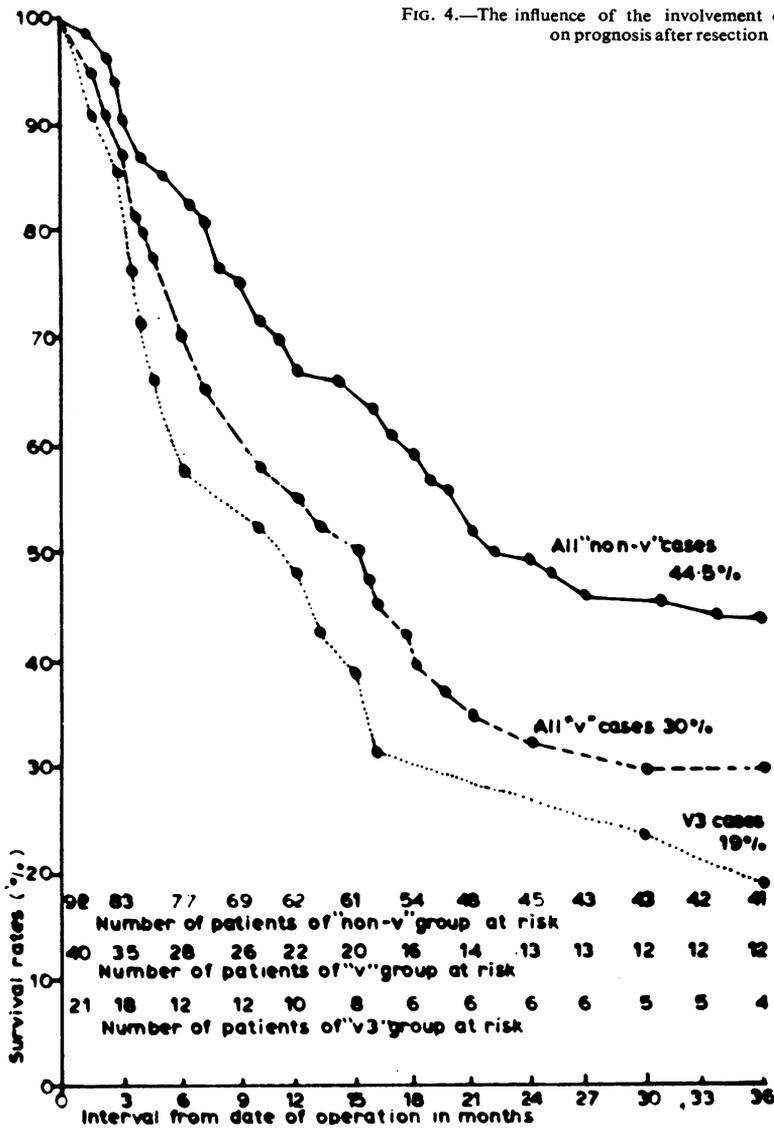
FIG. 3.—The influence of the extent to which lymph nodes are involved on prognosis after resection.



method we were able to show that there is some degree of pulmonary vein involvement in every case (Hinson and Nohl, 1960). In spite of the latter findings, Fig. 4 shows that infiltration of the larger veins, as demonstrated by the dissection method, exerts considerable influence on the chances of survival. That the incidence of vein involvement increases with the extent of the growth has already been shown in Table II. It must be pointed out that among the non-vascular group ("non-V" cases) there were many stage-3 cases, i.e., A₃, B₃, and C₃ cases, therefore those with mediastinal lymph node involvement. On

the other hand, in the vascular group ("V" cases) there were AV₀ and BV₀ cases, and yet the vascular infiltration in the whole group results in a worse prognosis. In this connexion it should be mentioned that major lymphatic involvement goes hand in hand with gross vascular infiltration. The growth in the hilar and mediastinal lymph nodes tends to invade by direct extension the vessels near the pericardium. The fate of these V₃ cases is clearly shown by the lowest curve in Fig. 4. Among these there were 13 CV₃ cases, that is the worst imaginable cases. Only one survived three years, i.e., an 8% survival rate.

FIG. 4.—The influence of the involvement of the pulmonary vein on prognosis after resection

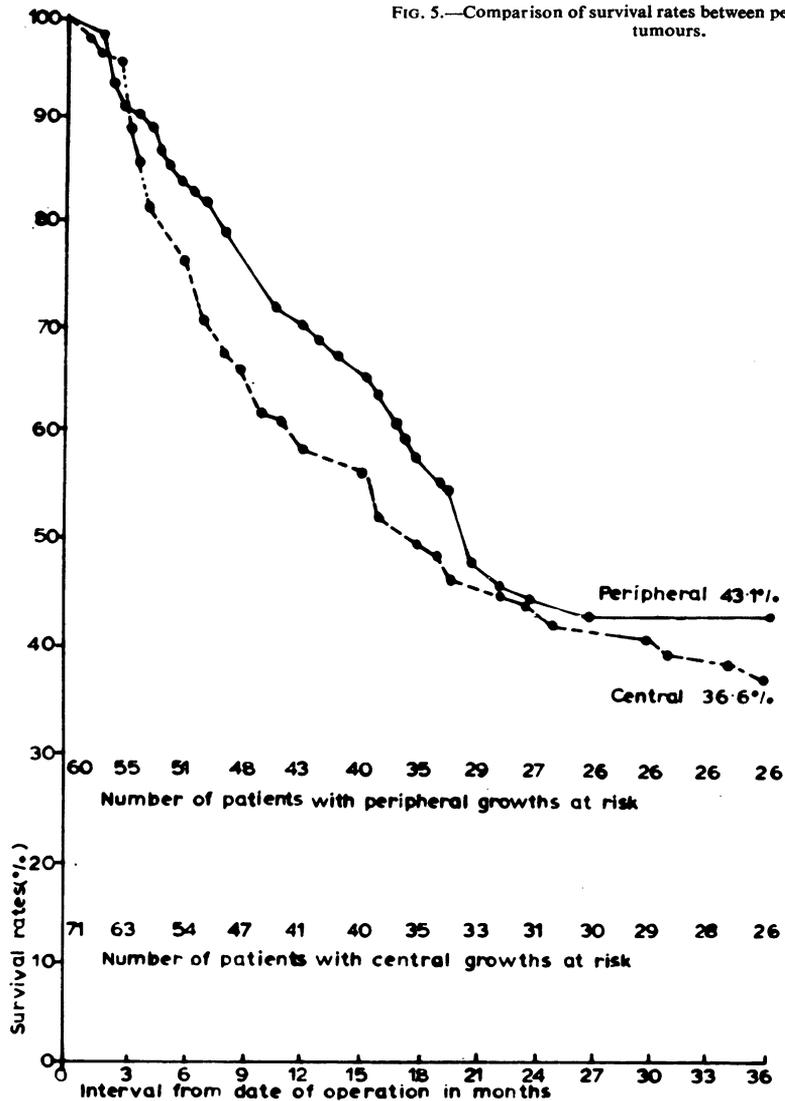


PERIPHERAL AND CENTRAL TUMOURS

Finally it was thought worth while comparing the fate of peripheral growths with the central types. For this purpose tumours were classified as central if they were visible on bronchoscopy. When one compares these two types where lymph node metastases and pulmonary vein infiltration are concerned, there is surprisingly little difference between them, except that the central growths show a slightly higher incidence of vascular

involvement. Hence the survival curve of the central tumours shows a correspondingly, though only slightly steeper, slope than the peripheral growths (Fig. 5).

In conclusion, it ought to be stressed that the above classification of carcinoma of the bronchus, like staging of carcinoma at other sites, can be of value in (1) analysing the different behaviour of the various histological types; (2) the assessment of various forms of treatment, for instance



lobectomy versus pneumonectomy, or resection with post-operative radiotherapy; and finally (3) that it allows one to give some sort of prognosis in each individual case, a fact which Borrie (1952) denied in his Hunterian Lecture.

I wish to express my thanks to the surgeons of the London Chest Hospital who wholeheartedly co-operated in this investigation, and especially to

Dr. K. F. W. Hinson, the pathologist, whose wise counsel and ready assistance made this research possible.

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RESULTS WITH RADIOTHERAPY ALONE

BY

GWEN HILTON

From the Radiotherapy Department, University College Hospital, London

I felt that I could not add, in the short time at my disposal, a great deal to the discussion by telling you in detail my results of radical radiotherapy in a large number of inoperable cases of cancer of the bronchus. These results have not altered much during the last 10 years; a few patients live several years; the majority do not live two years. The average duration of life after radical radiotherapy of those with an inoperable squamous carcinoma is 18 months, and with an oat-cell or undifferentiated carcinoma 14 months, and with an adenocarcinoma is 28 months. This last figure must be looked on with caution, as the number of cases is small. The value of palliative radiotherapy if properly given for the relief of symptoms, such as pressure on the superior vena cava or oesophagus, haemoptyses and dyspnoea, in the inoperable cases of carcinoma of the bronchus, is, I think, now accepted, at any rate in England. I thought it would be much more interesting if I told you the results of radiotherapy alone in a group of operable cases of cancer of the bronchus. We considered the experiment without surgery justifiable, as we have evidence from our experience that malignant cells in some cases of carcinoma of the bronchus can be locally eradicated by irradiation. In a series irradiated pre-operatively at the Hammersmith Hospital, nearly 50% were found to be free from tumour cells in the chest at an operation which was carried out subsequently.

We have treated 38 operable cases with radiotherapy alone and no subsequent operation; the diagnosis was assured by biopsy or by finding malignant cells in the sputum. The majority of the patients were bronchoscoped by Dr. Smart, and then kindly referred to me for radiotherapy. No clinical or radiological evidence of local or distant secondary growths could be detected clinically, and these cases would be judged suitable for pneumonectomy. The general condition of all the cases selected for irradiation was fairly good. Twenty-four of them were of squamous-cell carcinoma, nine were of anaplastic or oat-cell carcinoma, one of adenocarcinoma, and four others of undetermined type. The following table shows the patients' duration of life.

DURATION OF LIFE OF 38 OPERABLE CASES OF CARCINOMA OF THE BRONCHUS TREATED BY RADIOTHERAPY

More than 1 year	27 patients
.. .. 2 years	18 ..
.. .. 3	9 ..
.. .. 4	8 ..
.. .. 5	8 ..
.. .. 6	7 ..
.. .. 7	4 ..
.. .. 8	2 ..
.. .. 9	1 ..

Nine of them died in less than a year and the majority died in less than three years. Nearly half of them lived over two years. But eight of them lived for more than five years. One is now alive more than nine years and is carrying on with his work as a plasterer. By examining these eight more carefully, can we obtain any helpful information as to why they survived or not? It is well known that a few patients with carcinoma of the bronchus survive for a number of years without any treatment whatever, but it is unlikely that eight such cases should be included in our small series. In other words, we consider that radiotherapy alone has in some cases definitely lengthened the expectation of life. And during their lifetime, these eight patients were able to lead a normal life until their last year; they were not invalids, and they were able to carry on with their usual occupation until within a few months of death.

Normally, as we have seen, the duration of life is related to the histological type, but in these cases no such relationship is evident. Four of the patients who have survived more than five years (two are still alive) had oat-cell or undifferentiated cancers and four had squamous carcinomas. We are all aware of course that a histological section can only show a small portion of the growth, so that the section examined may not be truly representative of the whole tumour.

The site of the tumour in the 38 cases was fairly evenly distributed between right and left upper and lower lobes, but it is interesting to note that the growth was situated in the right lower bronchus in six of the eight patients who lived more than five years. Metastases outside the thorax occurred during the first year or two after treatment in the majority of the 38 patients in this series, but in the patients who lived for more than five years there was no such extension outside the thorax for at least five or six years after treatment. The accompanying graph shows a comparison of survival between 33 of these cases treated with radiotherapy alone and those treated by surgery only. This was published by Professor Smithers and Dr. J. R. Bignall in an admirable monograph. At first, the curve for the survival

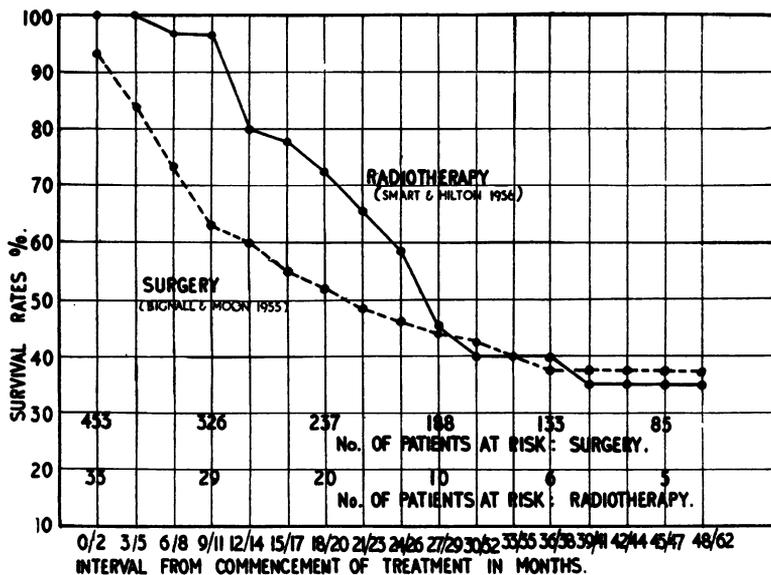


FIG. 1.—Survival of patients with operable carcinoma of the bronchus after surgery and radiotherapy (10% operative mortality omitted from surgical figures; no immediate radiotherapy mortality). Graph reproduced from *Neoplastic Disease at Various Sites*, Vol. 1, by kind permission of Professor D. W. Smithers and Dr. J. R. Bignall.

rate of the radiotherapy cases alone is perhaps a little different from surgery, but after two years they follow the same line. This is a small series, but each case has been most carefully studied and individually treated.

It seems to me that there are a small number of cases of carcinoma of the bronchus, irrespective of the histology, which remain localized within the thorax for a considerable time. It is only patients within this group whom it is perhaps possible to cure with the means we have at our disposal at the present time. In the majority of patients, the growth has most likely metastasized to organs outside the thorax by the time they are first examined, so that the patient will not be cured whatever method, surgical or radiotherapeutic, is used to treat the primary growth in the thorax. It is probable that the growth in the lung was not entirely eradicated in six of the eight patients who survived more than five years, and that some viable tumour cells remained enclosed in fibrous tissue. With conventional radiotherapy there is always some damage to the normal lung tissue if full dosage is given, but the changes are confined to the area irradiated. The art of course is to limit this damage to the smallest possible area. The pulmonary function is reduced in consequence of these changes, but not as much as after a pneumonectomy. All these cases were treated with kilovoltages between 250

and 300 with conventional radiotherapy, and the course of treatment lasted six to eight weeks. One had hoped that the results would have been improved by the use of megavoltage apparatus. Apart from an easier administration of the dose and less reaction of the normal tissues, the published results so far have shown no improvement in the expectation of life. But even with megavoltage, post-irradiation fibrosis of the lung does still occur.

Since the shorter wavelength produced by the linear accelerator and cobalt units has not solved the problem, an attempt has been made to render the tumour cells more sensitive to irradiation. Experimentally, an increase of oxygen tension has rendered malignant cells more sensitive to irradiation. We are therefore continuing our treatment of operable cases of carcinoma of the bronchus by irradiating them under increased oxygen tension. So far they have tolerated up to two atmospheres of oxygen without an anaesthetic. It is too soon to report the results of this experiment, but it is hoped that this approach to the problem will enable us to eradicate the primary growth in the bronchus in more cases.

To sum up, it would seem legitimate to treat an operable case of carcinoma of the bronchus with radiotherapy alone if there is any clinical doubt that the patient is not well enough for a major operation.

LONG-TERM FUNCTIONAL RESULTS AFTER PNEUMONECTOMY

BY

L. FEINMANN

Newcastle upon Tyne

I recently examined 31 patients from the Newcastle Clinic, all of whom had survived treatment for proved carcinoma of the bronchus for more than five years, and I am going to try and describe the quality of their survival.

The patients are aged between 37 and 75 and were treated between 1946 and 1952, as shown in Fig. 1. Thirty had pneumonectomy and in three cases this was followed by deep x-ray therapy. One had deep x-ray therapy alone.

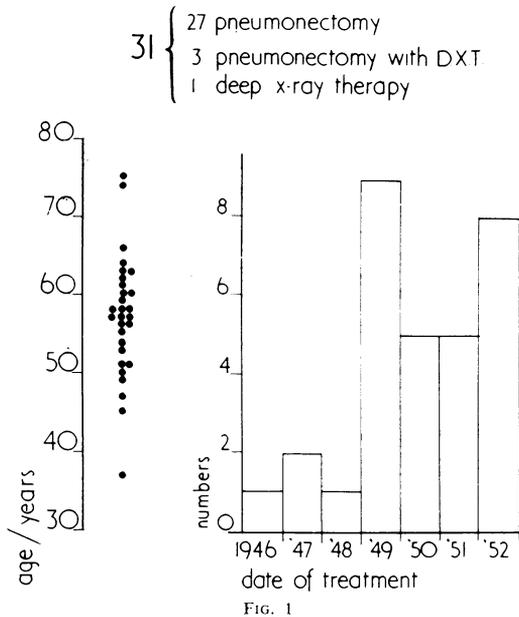


FIG. 1

Pulmonary function can be approached subjectively by describing the patient's symptoms, by his working ability and employment record, and by measurement. Because the management of bronchial carcinoma in the industrial north is so often dominated by coincident bronchitis, I first asked about cough, wheeze, sputum and bronchitic illnesses, along the lines of several recent surveys, to decide how much a patient had suffered from bronchitis. I thought that six of them had no bronchitis and 13 only mild symptoms, but the remainder had moderate or severe bronchitis;

BRONCHITIS

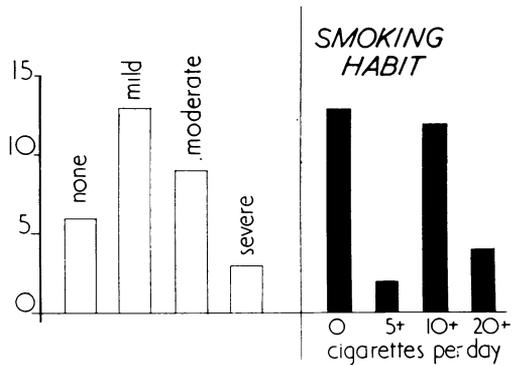


FIG. 2

incidentally most of the patients still smoked, some of them very heavily (Fig. 2).

I used Fletcher's standard questions for the patient's account of dyspnoea.

None of the group I examined could climb as well as normal people, but 13 considered they could keep up with their fellows for any distance on the level (Fig. 3). (One had been on a 12-mile ramble the week-end before I saw him.) Twelve could walk long distances at their own speed, four had to stop after walking a hundred yards or so because of dyspnoea, while two became dyspnoeic on very mild exertion, for example, when undress-

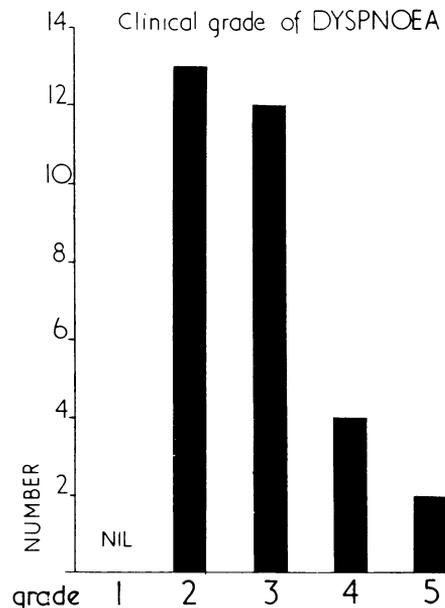


FIG. 3

ing. None of the patients I saw had been in congestive heart failure.

Of the 31 patients, 23 were working, though only seven were working at the same job as before treatment (Fig. 4). Of the workers, only 10 had lost more than a month's work in a year because of illness. Employment is not a very sensitive index of pulmonary function. One of the fittest patients I saw had not worked since his operation because there is no work in a mining village for a moderately disabled man. The most disabled patient had never lost a day off work since he recovered from his operation and had risen from secretary to managing director.

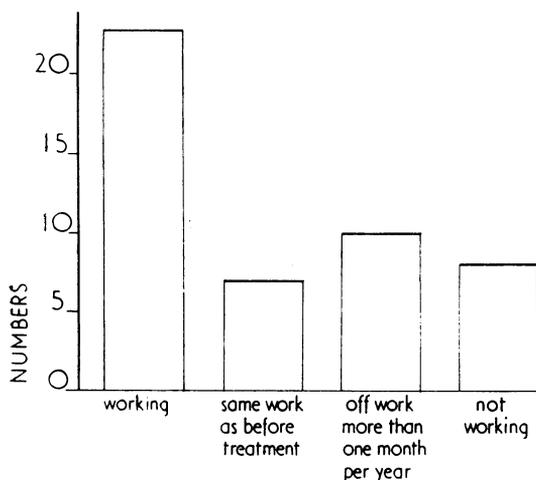


FIG. 4

Baldwin, Cournand, and Richards (1948) have shown that a patient begins to notice dyspnoea on exertion when ventilation reaches between 30% and 40% of his maximum voluntary ventilation. You will remember that Hugh-Jones (1952) devised a standardized exercise test, in which the patient was given 350 kg.-metres of work to do per minute, broadly the equivalent of stepping briskly upstairs. A normal man at any age breathes at about 8 litres a minute at rest and uses about 25 litres a minute for this amount of work. If, for example, this man has an M.V.V. of 100 litres a minute, his dyspnoic index is expressed as $25 \times \frac{100}{100} = 25\%$. Some of the patients I saw had exercise ventilation in the normal range, but others used 50 or even 60 litres a minute in order to do this amount of work, presumably because of impaired diffusing capacity across the remaining alveolar surface. Fig. 5 illustrates an example.

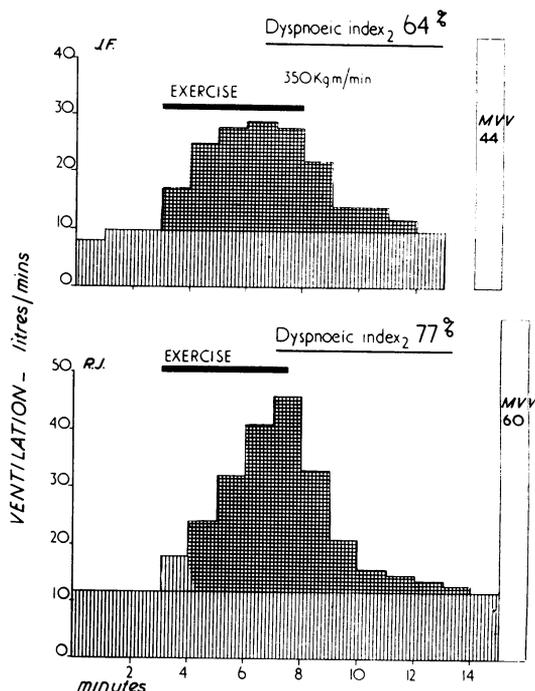


FIG. 5

R. J. has a much higher M.V.V. than J. F., but he needs nearly 50 litres a minute to do the same work that J. F. manages with 30 litres a minute: his dyspnoic index is higher and subjectively he is considerably more breathless.

I actually measured forced expiratory volume for three-quarters of a second in all patients and took the mean of the last three of five readings. The result was multiplied by 40 to give a measure of M.V.V. I measured the standardized ventilation on exercise on 25 patients. It would have been unkind to have attempted the test on those patients in Group 4 and 5 with much reduced M.V.V. and two of the others were not tested. Five completed the full five minutes' exercise and 16 of the remainder completed a satisfactory period of over two minutes' exercise. I made no attempt to press patients to go on and, in fact, had to restrain some elderly enthusiasts.

The results are shown in Fig. 6.

Normal figures for this age group lie above this diagram, M.V.V. \approx 100, D.I. \approx 30.

M.V.V. varies between 76 and 16 litres a minute, and the dyspnoic index between 50% and 176%. The M.V.V. does not separate patients with grades 2 and 3 of clinical dyspnoea, but the dyspnoic index gives much better separation.

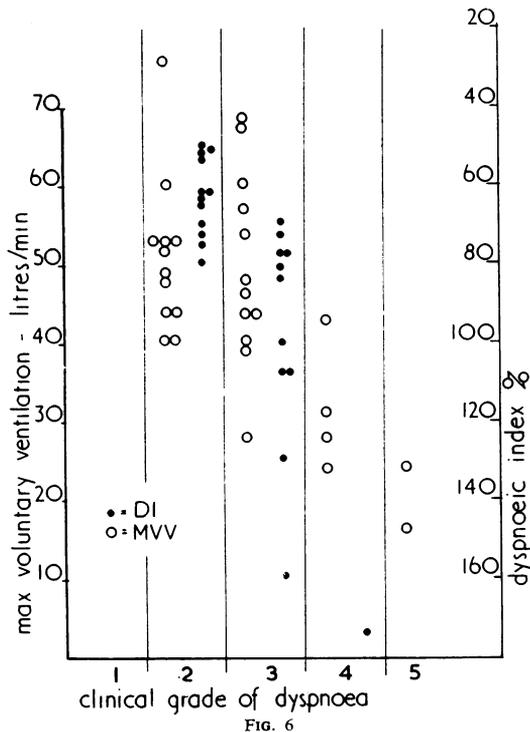


FIG. 6

The majority have a maximum voluntary ventilation of between 40 and 60 litres a minute, and whether this is associated with undue dyspnoea depends on their air requirements.

SOME BRIEF IMPRESSIONS

Age is no barrier: the oldest patient, aged 75, walks two miles a day, leads an interesting and active life, and, though his M.V.V. is only 40 litres a minute, he needs only 30 for this grade of exercise and managed three minutes of the exercise easily.

The functional results are not everything. Two of the most disabled patients, admittedly both in comfortable social circumstances, are the most grateful and happy in their long years of survival. A pleasant though terribly restricted life is possible on 20 litres a minute maximum ventilation.

To the observer the Hugh-Jones dyspnoeic index is a quite impressive test of pulmonary function in the assessment of the results of surgery. The apparatus is simple and the test also is simple to perform.

All the patients have lost considerable function as the result of successful radical treatment. I hope I have conveyed to you my own feeling that most are left with enough for a very worth-while life, and I end by paying tribute to the courage with which nearly all have surmounted their difficulties and, as I promised them, conveying their gratitude to the surgeons responsible for their survival.

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