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Chronic bronchitis: a 10-year follow-up

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A 10-year follow-up of 327 civil servants with bronchitis (301 men and 26 women) is presented. A further 14 were lost sight of during the period, so that the follow-up was 96% complete. More than one half (54%) of the men died during the 10-year period, some 57% of the deaths being attributed to respiratory causes and a further 8% to carcinoma of the bronchus. Mortality from these diseases was higher than among the general population, but other causes of death showed the normal pattern. The degree of dyspnoea noted at the first interview gave a useful estimate of prognosis, the mild, moderate, and severe groups showing progressively higher death rates. Neither the length of history nor the age at onset of symptoms could be related to mortality. The proportion of smokers among the patients was greater than expected in the general population, and although this may have been a factor contributing to the excess mortality of the group as a whole, it was not possible to determine any effect of smoking within this study.

In a previous communication (Medvei and Oswald, 1962) the results of a five-year follow-up of a group of civil servants with bronchitis were reported. The original selection of patients was based on sickness records maintained by the Treasury Medical Service. Employees were referred to the Bronchitis Clinic at the Brompton Hospital if their records showed either three absences from work during one year with a diagnosis of bronchitis or two such absences each lasting more than two weeks. These patients had their first clinical and radiological examination between March 1951 and September 1953, and the survivors were recalled for a second examination approximately five years later. The status of 305 of the 312 patients selected for this study was established as on the fifth anniversary of their first examination, and it was known that some of the seven patients who could not be traced had emigrated. The number of patients who died during the first five years was higher than expected among a sample of the general population having the same age distribution, and, as anticipated in a group selected on the basis of their respiratory disability, a large proportion of the deaths was attributed to respiratory or circulatory causes.

Since the initial examinations had been spread over a period of several years and there was in some cases a delay in tracing each patient five years later, the report on the five-year follow-up was limited to the 312 patients first seen before October 1953. In the remaining months of that year a further 29 patients were seen, but enquiries into their status five years later had not been completed when the earlier report was prepared. These patients have now been included in the study, and the survivors of the total of 341 patients first seen between March 1951 and December 1953 were recalled for a third examination approximately 10 years after their first one. Some were seen early and others late, but in all cases their status was finally established as on the tenth anniversary of their first examination. One of the seven patients who could not be traced after five years had returned to London from overseas and she was contacted again, but a further eight could not be traced at the end of the second quinquennium. Thus the present follow-up at 10 years refers to 327 of the 341 civil servants (96%) who had been enrolled for this study. Losing trace of 14 patients should not have biased the results appreciably, since some were known to have gone abroad and there was no reason to suspect that the death rate among the untraced patients differed substantially from that of the rest of the group. Of the 161 patients who were still alive 10 years after they were first seen, 94 attended for a further examination, 35 answered questions about their state of health by letter, and the remaining 32 were known still to be alive but no further details of their current state of health were available. Although some information was obtained concerning the change in

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clinical condition of the survivors during the 10-year period, it was incomplete and the 10-year prognosis has been based solely on the mortality experience of the patients.

There were 301 men and 26 women in the group considered in this report. Their ages ranged from 20 to 73 at the time of their first examination, and most of them were between 45 and 64 years old. All the patients were employed in Greater London, and at the beginning of the study most of them lived there too. Information about their subsequent moves was incomplete, but 21 (6%) were known to have lived outside Greater London throughout the period or until they died, and a further 32 (10%) were known to have moved out of the area during the course of the study. Although some may have left the urban area to seek a 'healthier' environment, the number of patients who moved was not large enough to study any possible effect of this.

At the first examination a full case report was completed for every patient. This included questions on family history, clinical history, smoking habits, occupational history, and findings from physical and radiological examination. Many of the questions were similar to those included in the standard questionnaire (Medical Research Council, 1965) which was introduced later. Where possible, the case reports were repeated at the second and third examinations. Changes in clinical condition and smoking habits were noted on the subsequent forms, but the mortality within the group was studied mainly in relation to the initial findings. The deaths in the first and second quinquennia of this study were considered separately in the first instance, but as the numbers occurring within each subdivision of age, clinical condition, or smoking habit were small, most of the analyses have been done for the 10 years as a whole.

RESULTS

More than half of the 301 men died within 10 years of their first examination, and the distribution of deaths by age is shown in Table I. Only four of the 26 women died during the same period. The male death rate (expressed here as a percentage of the number of patients in each age group) increased with age, though there was less difference in death rate between the young and the old than there would be in the general population. The numbers of deaths expected during the 10-year period 1951–1960 in a sample of the general population of England and Wales having the same age distribution as the patients were calculated from the life tables of Case, Coghill, Harley, and Pearson (1962). Within each broad age group shown in Table I there were more deaths among the men than expected, and in the two groups containing relatively large numbers of patients (45–54 and 55–64) the probability of obtaining the observed numbers of deaths in a sample of the general population was less than one in a thousand. The men undoubtedly had higher death rates than the general population, but the number of deaths among women was too small to assess whether their death rates differed significantly from those expected.

TABLE I

NUMBERS OF PATIENTS WHO DIED WITHIN 10 YEARS OF FIRST EXAMINATION

Age at First Examination	No. of Patients	Obs. Deaths		Exp. Deaths (gen. popn)	Ratio Obs./ Exp.
		No.	%		
Males					
20–44	27	4	15	0·8	5·0
45–54	84	37	44	9·4	3·9
55–64	167	104	62	41·0	2·5
65–74	23	17	74	10·3	1·7
All ages	301	162	54	61·5	2·6
Females					
20–44	9	0	0	0·2	—
45–54	14	3	21	0·7	—
55–64	3	1	33	0·4	—
65–74	0	0	0	0	—
All ages	26	4	15	1·3	3·1

For males, the probability of obtaining the observed numbers of deaths by chance is less than 0·001.

It was noted in the earlier paper (Medvei and Oswald, 1962) that the ratio of observed to expected deaths during the first five years declined with increasing age, and the same tendency is shown by the results for the complete 10-year period (Table I). It is likely that the criterion for admission to the series selected patients differently in the different age groups. Only a small proportion of young adults in the general population have repeated sickness absences, and the patients within the age range 20–44 were not representative of the general population. On the other hand, many old people have some form of chronic disease, and the expectation of life of patients already over 65 when they entered this study was unlikely to differ much from that of a random sample of the general population in that age range.

The dates of death of all the patients who have died since the beginning of this study have been tabulated so as to study any variations in death rate with season or with specific events such as

fog episodes or influenza epidemics. The distribution of deaths by season was similar to that of respiratory deaths in the general population: 39% occurred in the January to March quarter, 21% in April to June, 15% in July to September, and 24% in October to December. Since patients were enrolled in this study gradually from 1951 to 1953 it was necessary to determine the population 'at risk' before calculating the death rates in individual years or seasons. The number enrolled and still alive at the middle of each summer (April to September) and each winter (October to March) was determined so that seasonal death rates could be examined throughout the study. The numbers of deaths in each season were too small to determine whether the differences in death rate were significant, but the death rate during the winter 1952–53 was a little higher than in any other season. Twelve deaths were reported during the two months following the major episode of high pollution in December 1952 (Ministry of Health, 1954), and one of them was specifically attributed to the effects of the 'smog'. There was no other period of two months in this study in which as many as 12 patients died. The results have also been examined around the dates of other periods of high pollution in London since 1952 (Waller and Commins, 1966), but there was no tendency for the deaths to be 'clustered' after other episodes. There was no marked increase in mortality in the autumn of 1957, when an epidemic of 'Asian' influenza spread throughout the country (Ministry of Health, 1958).

The certified cause of death was known for most of the patients who died within 10 years of their first examination. The deaths were classified according to the underlying cause rather than the ultimate mode of dying, using the conventions adopted by the Registrar General. In Table II the numbers of deaths among men, attributed to respiratory and other broad groups of diseases, have been compared with those expected in a sample of the general population.

There was a large and significant excess of deaths due to respiratory diseases (mainly bronchitis, with or without emphysema) and a smaller but still significant excess due to lung cancer. The numbers of deaths from all other causes were close to those expected in the general population. Respiratory diseases and lung cancer together accounted for 65% of the male deaths from known causes, and circulatory diseases for another 18%. These results were not surprising, since the patients had been selected on the basis of existing respiratory disease. Two of the four deaths among women were attributed to respiratory diseases, one to lung cancer, and the fourth to cancer of the rectum.

The number of deaths in this study was not large enough to warrant analysis in respect of each attribute that had been determined at examination, but the deaths from all causes among men have been studied in relation to the severity of breathlessness, duration, and age at onset of bronchitis history and smoking habits.

In Table III the deaths have been classified according to the degree of breathlessness noted at the first examination. The numbers of deaths

TABLE II

CAUSES OF DEATH IN MEN (ALL AGES)

Cause	Int. List No.	Obs. Deaths		Exp. Deaths[2] (gen. popn)	Ratio Obs./ Exp.
		No.	%[1]		
Respiratory disease	470–527	90	57	8·8	10·2
Carcinoma of lung	162–163	12	8	5·6	2·1
Cancer of other sites	140–161, 164–239	10	6	8·9	1·1
Circulatory disease	400–468	28	18	21·9	1·3
Vascular lesions C.N.S.	330–334	7	4	6·6	1·1
Other specified diseases	—	10	6	8·5	1·2
All specified causes	—	157		60·3	—
Cause not stated ..	—	5		—	—

[1] Number of deaths expressed as a percentage of the total of 157 deaths from all specified causes.

[2] The expected deaths have been calculated for a sample of the male population of England and Wales having the same age distribution as the 296 men who were still alive or whose cause of death was known. For respiratory diseases the probability of obtaining the observed number of deaths by chance is less than 0·001, and for carcinoma of the lung it is less than 0·01.

TABLE III

DEATHS WITHIN 10 YEARS BY DEGREE OF BREATHLESSNESS, MALES, ALL AGES

Breathlessness Category[1]	No. of Patients	Obs. Deaths		Exp. Deaths (gen. popn)	Ratio Obs./Exp.
		No.	%		
0	47	11	23	6·6	1·7
1	80	31	39	15·0	2·1
2	96	59	61	21·9	2·7
3 or 4	78	61	78	17·9	3·4

[1] 0 Capable of heavy work; normal
1 Capable of moderate work; breathlessness confined to heavy work.
2 Capable of light work; breathlessness on walking quickly or hurrying; can climb a dozen stairs without undue distress
3 Capable of sedentary work; breathlessness on walking at moderate speed on the flat; has to stop for breath after climbing a dozen stairs
4 Capable of no work; breathlessness on the slightest exertion; able to potter around the house

The probability of obtaining the observed numbers of deaths if the patients in each category had the same death rates as the general population is less than 0·001.

in categories 1, 2, and 3 or 4 are all significantly greater than expected in the general population, and there is a steady increase in the death rate (expressed as a percentage of the number of patients in each category) from category 0 ('normals') to the combined category 3 and 4.

Since the older patients have the more severe symptoms it is necessary to consider whether the relationship between breathlessness and mortality is mainly an effect of age, and in Table IV the data have been regrouped by age in three breathlessness categories (combining 0 and 1 as well as 3 and 4).

TABLE IV

DEATHS WITHIN 10 YEARS, BY AGE AND BY DEGREE OF BREATHLESSNESS AT FIRST EXAMINATION, MALES ONLY

Age at First Examination	Breathlessness Category[1]	No. of Patients	Obs. Deaths		χ^2 for Trend
			No.	%	
20–44	Mild (0, 1)	22	3	14	—
	Moderate (2)	4	1	25	
	Severe (3, 4)	1	0	—	
45–54	Mild	34	8	24	$\chi^2 = 9{\cdot}1$
	Moderate	24	13	54	$P < 0{\cdot}01$
	Severe	26	16	62	
55–64	Mild	69	30	43	$\chi^2 = 11{\cdot}4$
	Moderate	57	39	68	$P < 0{\cdot}001$
	Severe	41	35	85	
65–74	Mild	2	1	50	—
	Moderate	11	6	55	
	Severe	10	10	100	

[1] The breathlessness categories are defined in Table III.

The trend has been examined in terms of a linear relationship between the death rate in each category and the numerical value of the breathlessness code. P is the probability of obtaining the observed numbers of deaths if these two quantities are not related to one another.

Within the two main age groups there is still a significant increase in death rate with the degree of breathlessness, and in the youngest and oldest patients the tendency is the same, although the numbers are too small to demonstrate any significant effect. All the patients aged 65 or over with 'severe' breathlessness died within 10 years of their first examination. Within each breathlessness category the death rate did not increase very rapidly with age. Among men considered to have a 'moderate' degree of breathlessness when first seen, 54% of those aged 45–64 died within 10 years, compared with 68% of those who were 10 years older, and 55% of those 20 years older. The prognosis for patients with different degrees of breathlessness can be followed from the Figure, which shows the mortality in three broad categories year by year from the time of the first examination.

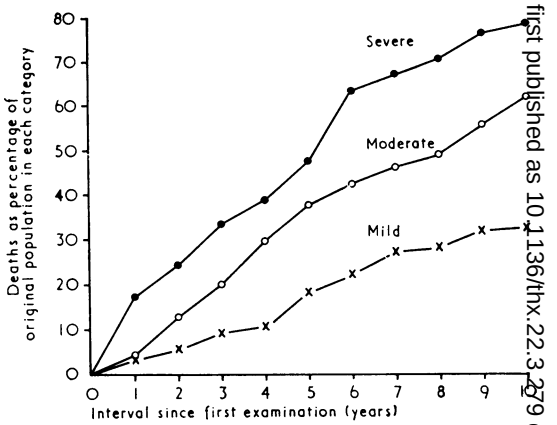

FIGURE. *Cumulative mortality at yearly intervals since first examination, by breathlessness category, males, all ages.*

Throughout this study mortality was highest among patients originally placed in the 'severe' breathlessness category and lowest among those placed in the 'mild' category. It appears that classification by degree of breathlessness provided a useful guide to prognosis. Fifty per cent of the patients with severe breathlessness died within five years and 50% of those with moderate breathlessness died within eight years. A similar variation in mortality with degree of breathlessness was found when this analysis was repeated for patients within the age range 55–64 only. There were not enough patients in other age groups to make separate year by year assessments for them, but within this series a knowledge of breathlessness category appeared to be more useful than knowledge of age. Deaths have also been classified according to the length of bronchitis history (Table V), but there is no consistent or significant trend in death rate with this variable. The data have also been considered in a number of different age and length of history classifications, but in none is there any clear indication that the length of bronchitis history makes any difference to the subsequent death rates. An alternative approach is to consider the age at onset of the disease. From Table VI it can be seen that approximately half of the men reported that their bronchitis began before they reached age 45. There is evidence from this Table of an increasing death rate with more advanced age at onset; but this may be due primarily to differences in the actual ages of the patients (there were, for example, no patients in the 65–74 age group reporting the age at onset before 20). In Table VII deaths have been tabulated by age as well as by age at onset. There

TABLE V

DEATHS WITHIN 10 YEARS, BY AGE AND BY LENGTH OF BRONCHITIS HISTORY WHEN FIRST SEEN, MALES ONLY

Age at First Examination	Length of History (years)	No. of Patients	Obs. Deaths	
			No.	%
20–44	0–4	9	1	11
	5–14	13	2	15
	15+	5	1	20
45–54	0–4	20	10	50
	5–14	38	18	47
	15+	26	9	35
55–64	0–4	54	25	46
	5–14	52	37	71
	15+	61	42	69
65–74	0–4	9	7	78
	5–14	8	6	75
	15+	6	4	67

TABLE VI

AGE AT ONSET OF BRONCHITIS AMONG ALL MALE PATIENTS AND AMONG THOSE WHO DIED WITHIN 10 YEARS

Age at Onset of Bronchitis	Patients		Obs. Deaths	
	No.	%[1]	No.	%[2]
0–19	28	9	8	29
20–44	122	40	63	52
45–54	86	29	50	58
55–64	60	20	36	60
65–74	5	2	5	100

[1] Number expressed as a percentage of the total number of patients.
[2] Deaths expressed as a percentage of the number of patients in each category.

are no significant differences in death rate with age at onset within the 55–64 age group, and in other age groups there are only erratic variations based, in most cases, on very small numbers of deaths.

TABLE VII

DEATHS WITHIN 10 YEARS, BY AGE AND BY AGE AT ONSET OF BRONCHITIS

Age at First Examination	Age at Onset of Bronchitis	No. of Patients	Obs. Deaths	
			No.	%
20–44	0–19	4	0	0
	20–44	23	4	17
45–54	0–19	12	1	8
	20–44	46	22	48
	45–54	26	14	54
55–64	0–19	12	7	58
	20–44	48	34	71
	45–54	59	35	59
	55–64	48	28	58
65–74	0–19	0	0	0
	20–44	5	3	60
	45–54	1	1	100
	55–64	12	8	67
	65–74	5	5	100

A large proportion of the whole group were or had been smokers, and the information on smoking habits collected at the first examination is shown in Table VIII. The difference in smoking habits between the patients and the general population was significant: there were more cigarette smokers and fewer pipe smokers and non-smokers than expected. Only 3% of the men had never smoked.

TABLE VIII

SMOKING HABITS OF THE PATIENTS AT THE BEGINNING OF THE STUDY

	Males[1]			Females		
	Obs. No.	%[2]	Exp. No.	Obs. No.	%[2]	Exp. No.
Cigarette smokers only	204	68	168	21	81	10
Pipe or mixed pipe/cigarette smokers	59	20	66	0	0	0
Ex-smokers	29	10	} 66	0	0	} 16
Never smoked	8	3		5	19	

[1] No information on smoking habits is available for one man.
[2] Number in each smoking category expressed as a percentage of the total number of patients with known smoking habits.
The expected numbers in each category have been estimated from data supplied by the Tobacco Research Council (Todd, 1966). For males and for females the probability of obtaining the observed numbers by chance is less than 0·001.

The full analysis of deaths occurring in men by smoking habits is shown in Table IX. When all ages were considered together, the differences in death rates between the several smoking categories were small, and the death rate among non-smokers (based on only three deaths) was less than that among smokers. There are some differences between categories in the individual age groups shown in Table IX, but in most cases the numbers of deaths are too small for any conclusions to be reached. Thus in the youngest age group the cigarette smokers and ex-(cigarette) smokers fare well in comparison with the others, whereas in the 45–64 age group ex-smokers have the highest rate, followed by the cigarette smokers. Of the 13 men and women who died from lung cancer 10 had smoked cigarettes, one smoked cigarettes as well as a pipe, and two were ex-(cigarette) smokers.

A small proportion of the patients gave up smoking during the course of this study, and in Table X their death rates are compared with those of the patients who continued to smoke throughout. In all but the oldest age group the rate among those who ceased smoking was less than among those who continued, and for all ages taken together the difference was significant at the 5% level. It is interesting, too, to compare these results

TABLE IX

DEATHS WITHIN 10 YEARS, BY AGE AND BY SMOKING HABITS, MALES ONLY

Age at First Examination	Smoking Category	No. of Patients	Obs. Deaths	
			No.	%
20–44	Ex-smokers	3	0	0
	Cigarette only	17	1	6
	Pipe or mixed	3	2	67
	Non-smokers	4	1	25
45–54	Ex-smokers	10	7	70
	Cigarette only	59	25	42
	Pipe or mixed	15	5	33
	Non-smokers	0	0	0
55–64	Ex-smokers	14	9	64
	Cigarette only	113	72	64
	Pipe or mixed	35	20	57
	Non-smokers	4	2	50
65–74	Ex-smokers	2	1	50
	Cigarette only	15	12	80
	Pipe or mixed	6	4	67
	Non-smokers	0	0	0
All ages	Ex-smokers	29	17	59
	Cigarette only	204	110	54
	Pipe or mixed	59	31	52
	Non-smokers	8	3	38

The one man for whom no information on smoking habits was available was in the 55–64 age group and he died within 10 years of his first examination.

TABLE X

DEATHS WITHIN 10 YEARS AMONG PATIENTS WHO CONTINUED OR GAVE UP SMOKING DURING THE STUDY, MALES ONLY

Age when First Seen	Smoking	No. of Patients	Obs. Deaths	
			No.	%
20–44	Continued	18	3	17
	Ceased	2	0	0
45–54	Continued	61	26	43
	Ceased	13	4	31
55–64	Continued	131	89	68
	Ceased	17	3	18
65–74	Continued	18	13	72
	Ceased	3	3	100
All ages	Continued	228	131[1]	57
	Ceased	35	10[1]	29
	Ex-smokers from start	29	17	59
	Non-smokers	8	3	38
	No information	1	1	—

[1] The probability of obtaining the observed numbers of deaths if giving up smoking makes no difference to the death rate is between 0·02 and 0·05.

with the figures for patients who had given up smoking before they entered this study (Table X, or by age in Table IX). The death rate among these 'ex-smokers' was about the same as among continuing smokers.

DISCUSSION

In interpreting the results presented in this report it is important to keep in mind the fact that the patients were already suffering from repeated attacks of bronchitis when they were first seen. The diagnosis was based on a persistent cough, sputum, and dyspnoea in the absence of clinical or radiological evidence of other serious pulmonary or cardiac disease. Fifty-four per cent of the men and 15% of the women died within 10 years, and the causes of death were noted from death certificates, completed for the most part by general practitioners. The ratio of observed to expected deaths among men was 2·6, compared with 4·2 in the first five years of the study (Medvei and Oswald, 1962). The high mortality compared with that of the general population was to be expected in a group with established illness, and in a large proportion (57%) of the men who died, death was attributed to respiratory diseases. A further 8% were attributed to carcinoma of the lung, and these two categories together accounted for the excess mortality as compared with the general population ; the remaining causes of death showed a normal pattern. The older patients had a higher death rate than the younger ones, but the increase with age was not as pronounced as in the general population, and the ratio of observed to expected deaths was highest in the youngest age group.

The breathlessness category assigned at the first examination proved to be a good guide to prognosis. Within most age groups there was a steady increase in death rate with the degree of breathlessness, and within some breathlessness categories there was relatively little variation in death rate with age. Few of the patients with 'severe' breathlessness survived for 10 years.

Within this study no firm conclusions could be drawn regarding any relationship between the length of history of bronchitis, or age at onset of the disease, and subsequent death rates. Clinical experience had suggested that patients with short histories had a poorer prognosis than those with long-standing disease, but the findings from this study do not support this.

Cigarette smoking is believed to be an important factor in the development of chronic bronchitis (Royal College of Physicians, 1962), and in this group there were more cigarette smokers than expected among the general population. The smokers and the non-smokers had higher death rates than expected ; but all patients had been specially selected for the study because of their established bronchitic symptoms. Within this study it was not possible to determine the effect of smoking on mortality from respiratory diseases. Patients who said at their first examination that they had already given up smoking because of

their bronchitis had death rates that were similar to those of patients who continued to smoke. On the other hand, there was some evidence that those who subsequently stopped smoking fared a little better.

Peculiar difficulties are encountered in attempting to estimate the prognosis in patients with chronic bronchitis. They stem primarily from difficulties in definition. Some 15 years ago, when this study was started, the term bronchitis was applied less critically than it is now, with asthma, or at least reversible airways obstruction, and emphysema being accepted as part of the syndrome in the later stages. This description still holds in common parlance, and inevitably forms the basis of studies in prognosis based on the evidence of death certificates (Reid and Fairbairn, 1958; Medvei and Oswald, 1962). Recent advances, especially in respiratory physiology, are leading to a better understanding of the component parts. A recent publication sets out the differences between simple, mucopurulent, and obstructive bronchitis (Medical Research Council, 1965). The prognosis may be different in each of these. In addition, there are the problems of differentiating bronchitis or sputum production from asthma and emphysema, which have not yet been fully resolved (Fletcher, 1965). Eventually the importance of these variants will need to be assessed. Indeed, a start has already been made. Bates, Knott, and Christie (1956) concluded that diffusing capacity was of prognostic value in emphysema. Mitchell and Filley (1964), after following a group of bronchitics for two to six years, felt that their survival was adversely affected by right heart failure, secondary polycythaemia, impairment of ventilation, and abnormal blood gases.

These observations are only a beginning of an understanding of the clinical course of chronic bronchitis, which varies so much from one patient to the next. One may develop gross and intractable mucopurulent bronchial infection, another right heart failure. Some become breathless from airways obstruction and progressive emphysema. These clinical variants may carry differences in prognosis.

The present study shows that the clinical severity of breathlessness gives some guide to prognosis. Further careful observation among large groups of patients may allow the importance of other aspects of the history or symptoms to be assessed.

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