period of unconsciousness was curtailed greatly in the intrathecal group. Oral feeding in these patients could be resorted to much earlier, with better maintenance of nutrition and quicker recovery. Also the complications of nasal feeding during unconsciousness were minimized and nursing-time was saved.

Period of Stay in Hospital.—Table II shows the period of stay in hospital in the two groups. Only those who survived their period of stay were included in the analysis. The stay was much less in the intrathecal group.

Sequelae.—Before the introduction of steroids in the treatment of tuberculous meningitis a large number of patients suffered from sequelae, particularly in the severe group. Now with the use of steroids, especially intrathecally, the sequelae have been greatly reduced. Table III shows the relative incidence of sequelae in the two groups of patients. In the intrathecal group there were no sequelae in patients with moderate severity, whereas 2 out of 11 severe cases had sequelae—one with

TABLE II.—*Period of Stay in Hospital*

Group	Mean	Range
Oral ..	3 months 21 days	1 month 25 days to 7 months 25 days
Intrathecal ..	2 ,, 3 ,,	1 ,, 2 ,, ,, 3 ,, 26 ,,

TABLE III.—*Incidence of Sequelae*

	Oral Steroid Group			Intrathecal Steroid Group		
	Total No.	No. Survived	No. with Sequelae	Total No.	No. Survived	No. with Sequelae
Moderate	9	5	2 (40%)	3	3	0
Severe ..	11	3	2 (66%)	20	11	2 (18%)

paralysis of all four limbs and the other with marked dimness of vision. The latter at one time could not see anything, but she gradually recovered some sight before her discharge after a month and 25 days. In the oral steroid group the percentage of sequelae was much higher. In the moderate variety two (40%) out of five patients that survived had sequelae—one had hemiplegia and one had paralysis of the right lower limb. In the severe variety 2 (66%) out of the 3 patients who survived had sequelae—one with hemiplegia and the other with monoplegia. Unfortunately the patients under study could not be kept long in the ward owing to severe overcrowding, nor could they be followed up for any length of time as their attendance in the out-patient department was very irregular.

Summary

Forty-three severe and moderately severe cases of tuberculous meningitis in children were studied in detail and the effects of oral and intrathecal corticosteroid were compared.

In those who received intrathecal hydrocortisone the survival rate was much higher, the disease ran a shorter course, the periods of unconsciousness and stay in the hospital were much less, the sequelae were minimal, and the biochemical cure (in C.S.F.) was earlier.

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BIBLIOGRAPHY

Ashby, M., and Grant, H. (1955). *Lancet*, **1**, 65.
Cocchi, C. (1956). *Amer. Rev. Tuberc.*, **74**, 209.
Fyfe, W. M. (1959). *Arch. Dis. Childh.*, **34**, 334.
Godden, J. F. (1960). *Ned. T. Geneesk.*, **104**, 619.
Khatua, S. P. (1961). *J. Indian med. Ass.*, **37**, 332.
Kinsell, L. W. (1951). *Ann. intern. Med.*, **35**, 615.
Lorber, J. (1960). *Brit. med. J.*, **1**, 1309.
Medical Research Council (1948). Streptomycin in Tuberculosis Trials Committee, *Lancet*, **1**, 582.
Nickerson, G., Morgante, O., Macdermot, P. N., and Ross, S. G. (1957). *Amer. Rev. Tuberc.*, **76**, 832.
Smith, H. V., and Vollum, R. L. (1950). *Lancet*, **2**, 275.
Voljavec, B. F., and Corpe, R. F. (1960). *Amer. Rev. resp. Dis.*, **81**, 539.
—— Orton, S. P., and Corpe, R. F. (1959). Ibid., **80**, 388.
Wright, N. L. (1959). *Quart. J. Med.*, **28**, 449.

LUNG CANCER AMONG WHITE SOUTH AFRICANS

REPORT ON A FURTHER STUDY

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In a previous paper (Dean, 1959) I reported that, while white South Africans had long been the heaviest smokers of packeted cigarettes in the world, British male immigrants to South Africa who died between the ages of 45 and 64 had a mortality rate from lung cancer 44% higher than South-African-born white men of the same age-groups. Moreover, this higher lung cancer mortality among British male immigrants occurred in each of the five major South African cities and in the other urban and rural areas of South Africa. The lung cancer rate of British male immigrants also exceeded the lung cancer rate of male immigrants from other countries. Further, in Durban the lung-cancer rate was high for both South-African-born men and for British immigrants.

On the basis of the national average levels of cigarette consumption, the higher lung cancer mortality rate of the British immigrants was clearly not to be attributed to greater consumption of cigarettes. Nevertheless, it was possible that these immigrants were a special group of heavy-smoking men ; therefore a further inquiry was carried out to ascertain, so far as was possible, the smoking habits of both the British immigrants and the men of South African birth who died of lung cancer and those of a matched control group.

Outline of Inquiry

In the previous inquiry the basic statistical information had been obtained from the death certificates of all the men and women who had died from lung cancer between 1947 and 1956, supplied by the Population Registrar in Pretoria. Since the previous study, lung cancer statistics have become available for 1957, 1958, and 1959. During these years the British immigrants continued to have a much higher lung cancer rate than the South-African-born and other immigrants. For the second part of the inquiry a " control " was required for each man who died from lung cancer during the years 1947–56 so that their smoking habits could be compared. The procedure adopted to obtain the controls was to select the first male in the Register of Deaths, following each male lung cancer death, who had died in the same

calendar year, who fell within the same five-year age-group, and who was in the same birthplace group and the same place of residence prior to death. In the case of small towns it was sometimes necessary to go to the next small town listed in the Register of Deaths in order to obtain the control. For the year 1953, which was the mid-year of the survey from the point of view of the number of deaths, two controls were selected for each lung cancer death in order to increase the number of controls. Copies were made of all the death certificates, which gave the home address of the decedents at the time of death. The next problem was to trace the families of these men.

Personal letters were written to their widows or families explaining the purpose of the survey and asking them to complete a questionary. The questions relating to smoking habits were:

1. If he never smoked please put a (√) here .....
2. If he was not smoking at the time of his last illness but had smoked before that, please say for how many years he had given up smoking .....
3. When he did smoke please tick those items which seem to you to describe most accurately his smoking habits.

Cigarettes per Day	Pipe Tobacco per Week	Cigars per Day
Fewer than 5	1 oz. or less	1
About 5 ..	About 2 oz. (57 g.)	2
,, 10 ..	,, 4 ,, (114 g.)	3 or more
,, 15 ..	,, 8 ,, (227 g.) or more	
,, 20 ..		
,, 25 ..		
,, 30 ..		
,, 35 ..		
,, 40 ..		
,, 50 or more		

These letters, which were repeated on two further occasions when no reply was received, yielded only about 18% response. By 1959 most of the widows of the men concerned had left the home where they had been living when their husbands were still alive and many had moved to other cities. A full-scale search, employing assistants in the major cities and a number of part-time workers in small towns, became necessary. Eventually the families of 603 (54%) of the lung cancer decedents and 635 (51%) of the controls were traced. The rate of response in the different areas and by years is shown in Table I.

TABLE I.—*Response Rates by Areas and Years*

	No. of Lung Cancer Deaths	Response		Year	No. of Lung Cancer Deaths	Response	
		Lung Cancer Group %	Control Group %			Lung Cancer Group %	Control Group %
Union-born:							
5 main cities	335	59·1	57·9	1947	68	45·6	57·3
Other urban	342	45·3	40·6	1948	70	40·0	47·1
Rural ..	167	47·9	47·8	1949	79	45·6	32·9
Total	844	51·3	49·0	1950	77	39·0	39·0
				1951	105	53·3	48·6
U.K.-born:							
5 main cities	189*	63·0	56·9	1952	122	51·6	37·7
Other urban	58	77·6	64·0	1953	129	54·3	67·8
Rural ..	18	33·3	61·1	1954	153	58·8	63·4
Total	265	64·2	58·8	1955	154	62·3	50·6
				1956	152	70·4	39·5
Combined total ..	1,109	54·4	51·3	Total	1,109	54·4	51·3

* Includes three extra lung cancer deaths among U.K.-born, previously incorrectly coded, found since the previous paper was published.

A comparison was made of the returns obtained as a result of the original letter and those obtained through the other methods of inquiry, but they showed no material differences in the level of cigarette consumption per day for men in the same main categories of place of birth, residence, and cause of death. There therefore appeared to be no reason why the replies obtained from the different methods of inquiry should not be combined.

Although the response percentage was lower than that obtained in some other investigations into smoking habits, it proved possible to obtain information about the smoking habits of more than half the men aged 45–64 dying of lung cancer in South Africa during the years 1947–56, and the smoking habits fell into such clearly defined and consistent patterns as to suggest that the answers obtained may have been adequately representative of the smoking habits of all those dying from lung cancer.

The average age at death of the respondents was as follows:

	Union-born	U.K.-born
Lung cancer group	56.4 years	57·3 years
Control group	56·0 ,,	57·0 ,,

These figures appeared to be close enough to justify dispensing with age-standardization of the figures that follow.

Table II summarizes the smoking habits of the lung cancer and control groups in the main areas of South Africa. For this and subsequent tables, men who had given up smoking at the time of their last illness were classified according to the amount reported as most accurately describing their previous smoking habits.

The main percentages and levels of consumption of the respondents are given in Table III. In this and Table IV the figures are based on all cigarette smokers or all pipe smokers, and not, as in Table II, on those smoking only cigarettes or only a pipe.

It is clear that among both Union-born and U.K.-born men aged 45–64 the lung cancer groups contained higher percentages of cigarette smokers and heavier cigarette smokers than the control groups. This association between lung cancer and cigarette smoking appeared in all three types of area (with the exception of U.K.-born men living in rural areas, whose numbers were very small). Further, in the five main cities (Johannesburg, Capetown, Durban, Pretoria, and Port Elizabeth) there was a remarkable similarity in the cigarette-smoking habits of the two lung cancer and the two control groups respectively despite differences in place of birth and upbringing. Thus in the lung cancer group in the five main cities 93% of the Union-born men smoked cigarettes, and they smoked an average of 34 a day, while 95% of the U.K.-born smoked cigarettes and smoked an average of 33 a day. In the control group, 85% of the Union-born smoked cigarettes and smoked an average of 26 a day, while 89% of the U.K.-born smoked cigarettes and smoked an average of 27 a day.

When smoking habits were analysed by five-year age-groups (Table IV), the same similarity among lung cancer decedents regardless of country of birth was found in all urban areas, and among the controls regardless of country of birth in the five main cities. In rural areas there was much less cigarette smoking among the Union-born, while the few U.K.-born men living in rural areas were usually city dwellers who had retired to the country and had smoking habits very similar to those of U.K.-born men living in the cities.

TABLE II.—*Smoking Habits of Men aged 45–64 Dying of Lung Cancer in South Africa 1947–56 and of Controls.*

	Place of Birth	Non-smokers	Cigarettes-only Smokers				Pipe-only Smokers	All Other Smokers	Total	Total Recorded Lung Cancer Deaths
			1–20 a Day	25–45 a Day	50+ a Day	Total				
Lung Cancer Deaths										
Durban ..	Union	—	5	21	7	33	1	6	40	77
,, ..	U.K.	—	6	20	9	35	1	7	43	62
Johannesburg ..	Union	—	6	25	12	43	1	16	60	110
,, ..	U.K.	—	6	21	6	33	1	3	37	58
Capetown ..	Union	1	5	18	6	29	2	9	41	78
,, ..	U.K.	—	3	12	2	17	—	1	18	48
Pretoria and Port Elizabeth ..	Union	5	9	17	16	42	3	7	57	70
.. ,,	U.K.	1	1	16	—	17	3	—	21	21
5 main cities ..	Union	6	25	81	41	147	7	38	198	335
.. ,, ,, ..	U.K.	1	16	69	17	102	5	11	119	189
Other urban ..	Union	1	20	46	23	89	8	57	155	342
,, ,, ..	U.K.	1	7	20	12	39	—	5	45	58
Rural ..	Union	3	5	9	8	22	29	26	80	167
,, ..	U.K.	—	—	3	1	4	—	2	6	18
Total ..	Union	10	50	136	72	258	44	121	433	844
,, ..	U.K.	2	23	92	30	145	5	18	170	265
Other Deaths										Population 1951 Census
Durban ..	Union	6	20	19	9	48	3	6	63	6,937
,, ..	U.K.	3	12	17	7	36	3	1	43	3,478
Johannesburg ..	Union	6	19	23	6	48	4	3	61	15,304
,, ..	U.K.	1	13	11	3	27	2	5	35	4,978
Capetown ..	Union	5	17	12	4	33	—	3	41	10,310
,, ..	U.K.	3	11	8	1	20	1	4	28	3,321
Pretoria and Port Elizabeth ..	Union	4	15	16	1	32	5	13	54	10,919
,, ,,	U.K.	—	3	7	—	10	—	3	13	1,475
5 main cities ..	Union	21	71	70	20	161	12	25	219	43,470
.. ,, ,, ..	U.K.	7	39	43	11	93	6	13	119	13,261
Other urban ..	Union	19	35	30	8	73	21	42	155	70,806
,, ,, ..	U.K.	2	9	17	3	29	3	7	41	8,202
Rural	Union	12	13	6	2	21	28	29	90	55,767
,, ...	U.K.	—	1	6	1	8	1	2	11	1,910
Total	Union	52	119	106	30	255	61	96	464	170,043
,, ...	U.K.	9	49	66	15	130	10	22	171	23,373

It should be added that many widows of U.K.-born men stated that their husbands had been much lighter smokers before they emigrated to South Africa.

TABLE III.—*Percentage of Cigarette and Pipe Smokers and Average Levels of Consumption*

	Union-born		U.K.-born	
	Lung Cancer	Controls	Lung Cancer	Controls
Five main cities:				
No. of deaths	198	219	119	119
% cigarette smokers	93	85	95	89
Cigarettes per cigarette smoker per day	34	26	33	27
Cigarettes per man per day ..	31	22	32	24
% pipe smokers	22	17	13	16
Average pipe tobacco per week per pipe smoker (oz.)	3·8	4·6	3·4	3·3
Other urban areas:				
No. of deaths	155	155	45	41
% cigarette smokers	94	72	98	88
Cigarettes per cigarette smoker per day	29	24	35	30
Cigarettes per man per day ..	27	17	34	26
% pipe smokers	41	40	11	24
Average pipe tobacco per week per pipe smoker (oz.)	5·3	3·9	5·3	4·8
Rural areas:				
No. of deaths	80	90	6	11
% cigarette smokers	59	54	100	90
Cigarettes per cigarette smoker per day	25	19	27	29
Cigarettes per man per day ..	14	10	27	26
% pipe smokers	68	62	33	18
Average pipe tobacco per week per pipe smoker (oz.)	4·5	3·9	6·0	3·0
All areas:				
No. of deaths	433	464	170	171
% cigarette smokers	87	75	96	89
Cigarettes per cigarette smoker per day	31	24	33	27
Cigarettes per man per day ..	27	18	32	24
% pipe smokers	37	33	14	18
Average pipe tobacco per week per pipe smoker (oz.)	4·6	4·1	4·0	3·8

Occupation

The occupations of the lung cancer groups were analysed in order to investigate the possibility that the lung cancer decedents might have been employed in occupations exposed to air pollution to a greater extent than the controls. If this was so, and if men in these occupations smoked more than men in other occupations, it might then have happened that the association between smoking and lung cancer was wholly or largely indirect. The relevant figures are given in Table V. Occupations regarded as likely to involve exposure to air pollution included engineers, fitters, mechanics, machinists, painters and lorry drivers, while occupations *not* thought likely to involve exposure to air pollution were mainly clerical, administrative, and selling occupations.

There was thus no evidence that lung cancer decedents were employed to a significantly greater extent than the controls in occupations likely to be exposed to air pollution.

TABLE IV

	Cigarette Consumption per Man per Day			
	Union-born		U.K.-born	
	Lung Cancer	Controls	Lung Cancer	Controls
Five main cities:				
Aged 45–49 ..	34	21	36	27
,, 50–54 ..	29	22	32	20
,, 55–59 ..	34	22	35	27
,, 60–64 ..	31	23	29	22
All ages ..	31	22	32	24
Other urban areas:				
Aged 45–49 ..	32	21	29	31*
,, 50–54 ..	27	22	27	22
,, 55–59 ..	30	16	36	31
,, 60–64 ..	25	14	39	23
All ages ..	27	17	34	26

* Based on five deaths.

TABLE V.—*Analysis by Occupation*

Type of Occupation	Group	Union-born				U.K.-born			
		5 Main Cities	Other Urban	Rural	Total	5 Main Cities	Other Urban	Rural	Total
		Numbers of Men							
Likely to be exposed to air pollution	Lung cancer	99	80	8	187	61	28	—	89
	Control	126	97	6	229	57	23	2	82
Unlikely to be exposed to air pollution	Lung cancer	93	73	72	238	55	17	6	78
	Control	92	58	84	234	62	18	9	89

In 12 the occupation was not stated.

Average Age at Emigration and Death

An analysis of the average ages at emigration and death of the British immigrants showed that those who died from lung cancer between the ages of 45 and 54 years—that is, those who died at a relatively young age—emigrated from Britain at the late average age of 30.2 years, whereas those who died in the later age-group, 55 to 64 years, emigrated from Britain on the average six years younger (24.4 years). Thus those men who spent a longer time in Britain tended on the average to die from lung cancer at an earlier age than those who had emigrated when they were younger. This phenomenon did not occur among the controls, where the average age at emigration (23 to 24 years) was the same for those who died between 45 and 54 and between 55 and 64 years.

Union-born Men Who Visited Britain

It may be significant that the percentage (14%) of the Union-born men who died of lung cancer and had temporarily resided in Britain (for an average of 4.3 years) was higher than the percentage of those dying of other diseases (8%) who had temporarily resided in the U.K. This difference was pronounced in the five main cities, in the other urban areas, and in the rural areas. In the other urban areas of South Africa, 9.7% of the Union-born lung cancer decedents had visited Britain, for an average of 3.2 years, whereas only 1.9% of the controls had visited Britain, for an average of 1.4 years.

Discussion

From the information obtained in the present inquiry it has been possible to estimate the lung cancer mortality rates per 100,000 for Union-born and U.K.-born men aged 45–64 in each area for each type of smoking and, so far as numbers permitted, at each level of smoking. In making these estimates it was assumed that the 1,109 men who died of lung cancer aged 45–64 in 1947–56 were distributed between the different types and levels of smoking in the same proportions as the lung cancer decedents from the same place of birth and residential categories in Table II were distributed, and that the 193,416 white men aged 45–64 resident in South Africa at the time of the 1951 Census, taken as representing the average population for the years 1947–56, were distributed between the different types and levels of smoking in the same proportions as the "other deaths" in the same place of birth and residential categories. By dividing the former figures by the latter for each type and level of smoking and place of birth and residential category, the lung cancer mortality rates shown in Table VI were obtained.

I have given the estimated mortality rates so far as is possible for those smoking one type of product alone, for I know no meaningful way of combining cigarettes and pipe tobacco that adequately reflects their relative lung cancer risk, especially since the lung cancer mortality rate of men smoking a specified quantity of cigarettes plus pipe tobacco or cigars is not infrequently lower than the mortality rate of men smoking this quantity of cigarettes alone—possibly because the former include fewer inhalers.

TABLE VI.—*Lung Cancer in South Africa: Men Aged 45–64. 1947–56. Estimated Lung Cancer Mortality Rates Per 100,000 Per Annum*

Region	Place of Birth	Non-smokers	Cigarettes-only Smokers			Pipe-only Smokers	All Other Smokers	Total
			1–20 per Day	25–45 per Day	50+ per Day			
South Africa:								
Durban ..	Union	—	44	193	136	(58)	175	111
,, ..	U.K.	—	89	209	229	(58)	—	178
Johannesburg	Union	—	23	79	146	(18)	(390)	72
,, ..	U.K.	—	51	210	(220)	(56)	(66)	117
Capetown	Union	—	22	114	(113)	—	(226)	76
,, ..	U.K.	—	(61)	337	(445)	—	(57)	145
Pretoria and Port Elizabeth	Union	(75)	37	65	(97)	(37)	33	64
,,	U.K.	—	(29)	201	—	—	—	142
Five main cities	Union	19	29	100	180	48	139	77
,, ,, ,,	U.K.	(13)	61	234	249	93	109	143
Other urban	Union	—	28	74	139	18	66	48
,, ,, ..	U.K.	—	50	76	(258)	—	46	71
Rural ..	Union	(8)	13	51	(135)	35	30	30
,, ..	U.K.	—	—	(86)	(172)	—	—	94
Total ..	Union	8	25	83	156	30	59	50
,, ..	U.K.	(20)	56	158	245	42	89	113

	Non-smokers	Cigarette Smokers		Pipe Smokers	Total
		Up to 21 per Day	22+ per Day		
U.K.:					
Liverpool and Lancashire (Mersey)	49	221	281	117	216
Lancashire, W. and S.W. ..	36	133	270	142	144
Denbigh S.E., Flint, and Cheshire ..	31	146	305	71	154
N. Wales except Denbigh S.E. and Flint	(7)	81	618	68	102

Note: The figures in parentheses are based on fewer than five deaths in the lung cancer and/or control group.

As mentioned above, in compiling the estimates in Table VI, the smoking habits of the control group were taken as being representative of the current smoking levels of men aged 45–64 in 1947–56 who were still smoking and of the past smoking levels of ex-smokers. It has been possible to obtain an approximate check on the representativeness of these figures from a survey of smoking habits of men aged 45–64 in Johannesburg, Capetown, and Durban in 1960 carried out by Market Research Africa (Pty) Limited (1960, private communication). Table VII compares the figures for the 1947–56 controls with this 1960 survey.

As will be seen, the two sets of figures are reasonably close, the main difference being that the 1947–56 controls

TABLE VII

	Non-smokers	Cigarettes-only Smokers				Pipe-only Smokers	All Other Smokers	Total
		1–20	25–45	50+	Total			
Controls, 1947–56:								
Union-born (%)	10	34	33	12	79	4	7	100
U.K.-born (%)	7	34	34	10	78	6	9	100
1960 Survey in Johannesburg, Capetown, and Durban:		1–25	26–39	40+	Total			
Union-born (%)	11	41	14	16	71	9	9	100
U.K.-born (%)	8	41	16	15	72	8	12	100

had a higher percentage of men who smoked cigarettes only than the 1960 survey, which is perhaps contrary to expectation in view of the increased consumption of cigarettes in the Union in the past 10 years. So far as the percentages smoking different quantities of cigarettes only can be compared, it would appear that the 1947–56 controls may have a higher percentage of very heavy cigarette-only smokers.

It has, of course, been suggested by Berkson (1959) that smoking is associated with higher mortality generally. Consequently we have to consider the possibility that lung cancer mortality rates estimated on the basis of a calculation that used information about smoking habits derived from "other deaths" may have overestimated the lung cancer mortality rates of non-smokers and light smokers and underestimated the rates of heavy smokers. Had this been a factor of major consequence, one would have expected a much lower percentage of non-smokers in the 1947–56 controls than in the 1960 survey and an even greater difference than that shown in Table VII between the percentages of heavy cigarette-only smokers. In fact, it would seem fair to conclude, from the comparison with the 1960 survey, that there is no evidence to suggest that the smoking habits of the control group in this investigation were seriously unrepresentative of the smoking habits of men aged 45–64 living in South Africa in 1947–56.

The attempt to estimate lung cancer mortality rates separately for smokers of 25–45 cigarettes and of 50 or more cigarettes a day has given rise to a few anomalous figures, doubtless due to errors made by widows in estimating their late husband's level of cigarette consumption.

Even so, Table VI does bring out clearly a number of important points:

1. The lung cancer mortality rate of Union-born non-smokers living in rural areas was very small—of the order of 8 per 100,000, if the small number of respondents can be trusted.

2. Also in rural areas the lung cancer mortality rate of Union-born men smoking from 1 to 20 cigarettes a day—namely, 13 deaths per 100,000 per annum—was remarkably low. From this it would seem fair to conclude that any contribution to lung cancer made by moderate cigarette smoking in favourable atmospheric conditions is very small. This is in line with the results of Mills (1960), who estimated the lung cancer mortality rate of male non-smokers, apparently aged 40–69, in rural Ohio at 14 deaths per annum per 100.000 and the corresponding rate of "light smokers" (apparently defined as smokers of 1–14 cigarettes per day) at 10 deaths per annum per 100,000.

3. As one progresses either to higher levels of smoking or to greater levels of urbanization, the lung cancer mortality rates increase. The highest lung cancer mortality rates were found where heavy smoking was combined with exposure to urban air pollution.

4. In each area, for all types of smoking and at every level of smoking, the lung cancer mortality rate of British immigrants was, with a few rare exceptions where numbers were small, equal to or greater—and often substantially greater—than that of Union-born men. The immigrants were, of course, a self-selected group of the U.K. population and might have been expected to be healthier than the average of the U.K. population.

It is interesting to compare the lung cancer mortality rates of South Africa with those of the U.K. For this purpose I have included Stocks's (1958) figures for men aged 45–64 in Table VI. A minor difference, unlikely to invalidate a broad comparison such as this, lies in the slightly different definitions of the different categories of smokers. For example, in my figures, a non-smoker was a man who was reported by my informant as never having smoked; according to Stocks, a non-smoker was a man who "had never for any period averaged as much as two cigarettes a week and had not smoked a pipe nor cigars." My figures for cigarette smokers are for those who smoked cigarettes only, whereas Stocks's figures are for those who smoked cigarettes with or without other tobacco products and are classified according to the total quantity of tobacco smoked.

It would appear from these figures that non-smokers living anywhere in Stocks's areas except North Wales had about two and a half to three and a half times the lung cancer mortality rate of Union-born men living in rural South Africa who smoked 1 to 20 cigarettes a day. Other comparisons can readily be made, as the figures speak for themselves.

To illustrate further the basic differences between the lung cancer mortality rates of South Africa and the U.K., I have estimated (Table VIII) the number of lung

TABLE VIII.—*Theoretical Number of Lung Cancer Deaths in U.K. in* 1958 *on Basis of Mortality Experience of South African Rural Areas*

Smoking Category	No. of Men Aged 45–64 in U.K. in 1958 000	Lung Cancer Mortality Rates, 1947–56, of Union-born Men in Rural Areas per 100,000	Theoretical No of Deaths
1. Men who had never smoked	524	8	42
2. Current smokers or ex-smokers of packeted and/or hand-rolled cigarettes only:			
Under 25 cigarettes per day	3,056	13	397
25–49 cigarettes per day	936	51	477
50+ " " "	84	135	113
3. Current smokers "or" ex-smokers of pipes only	726	35	254
4. All other current smokers or ex-smokers	834	30	250
	6,160		1,533
Actual lung cancer deaths of men aged 45–64 in U.K. in 1958:			
England and Wales			9,118
Scotland			1,057
N. Ireland			149
			10,324

cancer deaths that would have occurred among U.K. men aged 45–64 in 1958 if they had been subject to the lung cancer mortality rates of Union-born men living in rural areas of South Africa in 1947–56, on the basis of data about U.K. smokers supplied by the Tobacco Manufacturers' Standing Committee, London (1960, private communication).

This calculation shows that if U.K. men aged 45–64 in 1958 had had the same lung cancer mortality rates at each level of smoking as Union-born men in rural South Africa had had in 1947–56, lung cancer among the U.K. men would have been about 15% of its actual level. If a similar calculation could have been made on the basis of South African figures for 1958, this last figure would probably have been of the order of 20–25%. There could, however, be differences between the extent to which smoking may have contributed to lung cancer in men classified as smoking the same quantities in the two countries. There were differences between U.K. and South African cigarettes and there may have been differences between the methods of smoking them—for example, frequency and volume of puff, prevalence of inhaling—and possibly also in the duration of the habit.

At present there are differences in the length of stub down to which a cigarette is smoked.

During the 1960 survey of smoking habits in the three largest cities, mentioned above, the interviewer was instructed to collect one cigarette stub from each man who finished a cigarette during the course of the interview. Less than 20% did finish a cigarette during the interview, but stubs were collected from 162 South African-born and 118 U.K.-born men aged 45–64 years. The stubs were sent for measurement to Dr. E. C. Halliday, Chief of the National Physical Research Laboratory of the South African Council for Scientific Research. In both groups, about 70% of the stubs were filter-tipped. The average stub-length for the South-African-born was 25.0 mm. and for the U.K.-born 25.6 mm., and the difference between the two groups was not significant. The average stub-length agrees with the two previous South African surveys (Dean, 1959). This is longer than the average stub-length for the U.K. reported by Doll *et al.* (1959), but, on the other hand, the average South African cigarette at the present time is longer than the average U.K. cigarette.

Nevertheless, it seems highly improbable that differences in the method or duration of smoking the same quantities of cigarettes per day or differences between the types of cigarettes smoked in the two countries could by themselves account for the difference between 10,324 and 1,533 lung cancer deaths a year among men aged 45–64. Stocks's estimates of the lung cancer mortality rates of male non-smokers aged 45–64 in the different parts of North Wales and Lancashire, quoted in Table VI, suggest that an average figure for U.K. non-smokers as a whole in this age-group might have been of the order of 40 deaths per 100,000 per annum. Even allowing for possible errors in estimation, the U.K. figure is likely to have been several times the figure of 8 deaths per 100,000 per annum for Union-born non-smokers in South Africa. As standards of diagnosis are high in South Africa, this difference would seem to be attributable to the greater prevalence of adverse air conditions in the U.K. This could reflect the effect of climate as well as air pollution.

Stocks, however, has also estimated that in the absence of both smoking and urbanization the lung cancer mortality rate of both men and women aged 35–74 in North Wales was of the order of 10 deaths per 100,000 per annum, and since this was not very different from my estimate of the rate for Union-born non-smokers in rural South Africa, after allowing for the difference in age-groups, it suggests that the British climate by itself is unlikely to be a major factor in contributing to lung cancer. It is therefore difficult to avoid the conclusion that air pollution is largely responsible for the higher lung cancer rate of non-smokers in the U.K.

Moreover, air pollution may have a more than additive effect on the lung cancer rate of smokers. Indeed, the lung cancer mortality rates for U.K. smokers aged 45–64, according to Stocks, exceeded the rate for U.K. immigrants to South Africa by considerably more than 30 deaths per 100,000 per annum at each level of smoking. Although many immigrants increased the amount they smoked after arriving in South Africa, there is still evidence for more than an additive effect by British air pollution among the lighter cigarette smokers. Further, the difference between the lung cancer mortality rates of Union-born men in the five main cities and the rural areas increased at each level from non-smokers (11 deaths per 100,000) to heavy cigarette smokers (45 deaths per 100,000), except for those smoking 50 or more cigarettes a day where numbers in the rural areas were small, suggesting that in South Africa also air pollution had a more than additive effect when combined with smoking. In fact, it would appear that in both South Africa and the U.K. the elimination of air pollution from urban areas would substantially reduce the incidence of lung cancer even if no change occurred in smoking habits. It is perhaps also pertinent to recall that, in U.S.A., Prindle (1961) has reviewed the available data, and concluded that 45%, instead of a much lower figure previously estimated by others, of the lung cancer deaths of white men aged 50–69 in communities of 2,500 or more could be associated with the effect of urbanization.

Conclusion

The rapidly rising incidence of lung cancer would appear to be caused by environmental factors. Carcinogens reach the bronchi through the air we breathe. Previous research, confirmed by this study, has shown that the incidence of lung cancer rises with increased cigarette consumption. The present study provides further strong evidence that the air pollution that accompanies modern urban life, particularly in Britain, is also a major factor in the causation of lung cancer. Apparently we can have either moderate smoking or moderate air pollution with relatively little risk, but we cannot have both and keep lung cancer rates down. In most British cities there is no escape from breathing heavily polluted air; cigarette smoking, however, is voluntary. The risk of lung cancer arising from this combination of factors could be reduced by preventing air pollution, and this would also diminish the incidence of bronchitis. We appear to be at the same stage of inadequate control of air pollution to-day as we were in preventing the contamination of drinking-water 100 years ago, and there is strong evidence that air pollution is causing serious harm to health and is responsible for many deaths.

Summary

In a previous paper it was shown that although the white South African was the heaviest cigarette smoker in the world he had a lung cancer incidence less than half the incidence in Great Britain. However, British men who emigrated to South Africa had a lung cancer mortality rate 44% higher than white South-African-born men between the age of 45 and 64 years. Immigrants from other European countries did not have a higher incidence of lung cancer than the white South African.

This further study is based on questionaries sent to the widows of the lung cancer patients and an equivalent group of controls. Details were obtained about the smoking habits of more than half the men aged 45–64 dying of lung cancer in South Africa during the years 1946–57. These showed that:

1. The lung cancer patients in South Africa had smoked more cigarettes, on average, than the controls; and the risk of lung cancer increased with heavier cigarette-smoking habits.

2. There was no evidence that those who died of lung cancer had been employed to a significantly greater extent than the controls in occupations likely to be exposed to air pollution.

3. The British immigrant who died from lung cancer at the earlier age, 45 to 54, emigrated from Britain at an average age of 30 years; those who died between 55 and 64 emigrated at an average age of 24 years.

4. The percentage of Union-born men who died of lung cancer and had temporarily resided in Britain was higher than the percentage of those dying of other diseases who had temporarily resided in Britain.

5. In South African rural areas the lung cancer mortality rate for men aged 45 to 64 years was very low for both non-smokers and moderate smokers, and increased only with heavy cigarette smoking. This suggests that, in the absence of atmospheric air pollution, smoking fewer than 20 cigarettes a day causes so little irritation to the bronchial cells that the risk of lung cancer is small. In both South Africa and the U.K. the elimination of air pollution from urban areas would substantially reduce the incidence of lung cancer even if no change occurred in smoking habits.

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REFERENCES

Berkson, J. (1959). *Proc. Mayo Clin.*, **34**, 206.
Dean, G. (1959). *Brit. med. J.*, **2**, 852.
Doll, R., Hill, A. B., Gray, P. G., and Parr, E. A. (1959). Ibid., **1**, 322.
Mills, C. A. (1960). *Amer. J. med. Sci.*, **239**, 316.
Prindle, R. A. (1961). In *The Air We Breathe*, edited by S. M. Farber, p. 177. Thomas, Springfield, Ill.
Stocks, P. (1958). *A.R. Brit. Emp. Cancer Campgn, 1957*, Suppl. to Pt. II.

CATARACT EXTRACTION AND DIABETES

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For many years it has been recognized that diabetics are prone to cataracts. Indeed, Bence Jones (1865) wrote, "There is no special complication belonging to diabetes unless it be cataract." It was then recognized to occur "early, at 30 or even at 19." Bouchardat (1852), France (1859), and von Graefe (1860) all wrote on the higher incidence of cataract in diabetics. Some authorities recognized that the failure of vision was worse if albuminuria was also present (Bouchardat, 1852; Harley, 1865), but it is likely they did not realize that this was probably due to the presence of retinopathy, almost always associated with albuminuria.

True diabetic cataract is of characteristic morphology, usually occurring bilaterally at the same time, and more commonly in younger diabetics. These cataracts are associated with a period of uncontrolled severe diabetes and are sometimes present at the time of diagnosis, but may appear also after good diabetic control has been established. Very occasionally the lens changes are reversed with continued treatment of the diabetes (Neuberg *et al.*, 1958); but surgical treatment is usually required. Much more common than diabetic cataract is the so-called "senile" cataract, which occurs at an earlier age in the diabetic. It is usually associated with vascular disease, poor control of the diabetes, and sometimes with a family history of cataract (Keen, 1960). Lens opacities may extend with varying degrees of speed, some remarkably slowly, but ultimately surgical extraction is required.

Extraction of the lens in the diabetic has been recognized for more than half a century to be a procedure fraught with risks greater than in the non-diabetic. In pre-insulin days these risks were held to preclude operation in the large majority of cases. Thus Glegg (1920) reported that of the 1,660 cataract extractions performed at the Manchester Eye Infirmary between 1899 and 1920, only 87 were in diabetics and in a large proportion of these there was a serious post-operative complication.

After the introduction of insulin in 1922, treatment of the diabetic became much more satisfactory and operation a less hazardous procedure. Subsequent improvements in surgical technique contributed to this added safety, and the outlook for the diabetic with loss of vision due to cataract is much less gloomy. Nevertheless, in referring to this greatly altered outlook, Nutt (1953) was impressed with the small number of diabetics (30) presenting for operation in Sheffield during the five years which he reviewed, and Dollfuss *et al.* (1958) commented upon a similar conservatism at l'Hôpital de la Pitié in Paris. From our own study it seems likely that only a proportion of patients with visual loss primarily due to cataract have presented for operation, since the incidence of cataract in 900 patients with onset of diabetes after the age of 40 attending the Royal Free Hospital diabetic clinics is some 33%, but only 27% of those with cataract have had lens extraction.

The complications feared in such operations are chiefly those of haemorrhage and infection. The possibility of haemorrhage, accompanied in exceptional cases by disastrous expulsion of the contents of the globe, provided in the past one of the main deterrents to surgery, and the frequent occurrence of an indolent hyphaemia, followed at times by secondary glaucoma, emphasized the operative risks from this cause. Delayed healing of the incision and severe post-operative

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