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SECTION VIII. ASBESTOS AND NEOPLASIA: EPIDEMIOLOGY

ASBESTOSIS AND PRIMARY INTRATHORACIC
NEOPLASMS

William D. Buchanan

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The purpose of this paper is to describe one aspect of a study, which has been continued over many years by the Medical Branch of Her Majesty's Inspectorate of Factories of the Ministry of Labour, of information on certificates of death relating to certain conditions which although not notifiable to the Inspectorate, have or may have an occupational causation. Among these conditions is fibrosis of the lung including pneumoconiosis in general and asbestosis in particular. In such cases, note has also been made of any coincident lung pathology.

Early References Associating Asbestosis and Malignancy

From time to time since a Departmental Committee on Compensation for Industrial Disease¹ first had the possibility of asbestos causing lung disease brought to its attention in 1906, my Department had shown interest in the matter but with no very definite conclusion emerging. Recognition of several cases of lung fibrosis in asbestos workers in the late 1920s, however, left little doubt as to the reality of the hazard, and in February 1928 an enquiry was initiated, the medical aspect being undertaken by my former chief, E. R. A. Merewether. The findings were the subject of an official report² issued in 1929, in which year Merewether³ also published a review of the condition and an account of his investigations. Up to that time there appeared to be nothing to suggest malignant disease as a complicating factor.

Credit for the first published suggestion of such an association is usually assigned to Lynch and Smith⁴ who in 1935 described the case of an asbestos weaver at whose death from asbestosis at the age of 57, a lung cancer was also found. Later that year, Gloyne⁵ published an account of two cases of squamous cancer of the lung occurring with asbestosis. One was a young woman aged 35, exposed, as a spinner, to asbestos for 8 years; the other, also a woman, aged 71, had, in all, 2 years' exposure in the mattress and opening department of an asbestos factory, but some 15 years previously. Wood and Gloyne⁶ had, however, reviewed in the Lancet the year before, a series of 100 cases of asbestosis seen since 1928, noting in 28 who had died, two cases of carcinoma of the lung and a third case with a few deposits of growth in the pleura. It is also worth noting that Gloyne⁷ in 1933, in discussing the complications and sequelae of pulmonary asbestosis, had included a case of abdominal carcinoma and one of squamous carcinoma of the pleura in a group with other complications, which in the

light of knowledge then available he considered to be incidental and unrelated to the asbestosis. Merewether has informed me that Gloyne had suggested to him the possibility of an association of asbestosis and pulmonary malignancy some time before 1935. Certainly in retrospect, our records show that by the end of 1935, out of just under 100 asbestosis deaths by then recorded, seven had a lung cancer. The first of these cases with malignancy, two in number, were recorded in 1932, one being the young woman described by Gloyne, the other a male asbestos compo mixer and sorter who died, aged 70, after an exposure to asbestos of some 30 years.

Source of Information

For many years now, we have enjoyed the cooperation of the Registrars General for England and Wales and for Scotland, who have supplied, routinely, copies of all death certificates relating to those diseases in which we have an interest. The asbestosis cases we ourselves have abstracted from the much larger group of certificates recording lung fibrosis due to any cause including pneumoconiosis.

We believe, despite the fact that asbestosis is not a formally notifiable industrial disease, that certification of the cause of death where asbestosis was diagnosed during life or found to be present at autopsy, is more accurate than for many other diseases. As a result, compilation of all such death certificates currently provides a reasonably accurate means of determining the number of persons dying, in whose lungs asbestosis has been present and, related to the high proportion of such cases coming to autopsy, other relevant pathological conditions present.

Until the middle 1950s, it was the practice to follow-up such information by finding as much detail as possible of the occupational history, but the time involved in doing this has made it impossible to continue the practice in all cases and the data in this paper are based therefore, with the exception of the very early years, when information came from other sources, on an analysis of the information as recorded on the death certificates.

We base this belief on a number of reasons. In Great Britain, pneumoconiosis, including asbestosis, is a condition entitling the victim to industrial injuries benefits under our National Insurance Act or, where the disease was contracted prior to 1948, the Workmen's Compensation Act. Under the industrial injuries provisions, death benefits, generally in the form of a pension, may be payable to eligible dependents. Payment of benefits is subject to confirmation that death resulted from the disease, normally based on autopsy findings. Periodic medical examinations are also undertaken by the Pneumoconiosis Medical Panels of workers in many occupations with an asbestosis hazard. Lastly, irrespective of any compensation aspects, death from asbestosis, being of unnatural causation, is an

TABLE I
ANALYSIS OF ASBESTOSIS AND CANCER OF THE LUNG AS AT 1947

Age in years at death	Males		Females	
	Asbestosis	Asbestosis and cancer of lung	Asbestosis	Asbestosis and cancer of lung
		Per cent		Per cent

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TABLE 1
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Age in years at death	Males			Females		
	Asbestosis	Asbestosis and cancer of the lung	Per cent	Asbestosis	Asbestosis and cancer of the lung	Per cent
15-24	3	—	—	0	—	—
25-34	9	—	—	33	2	6.1
35-44	30	—	—	41	4	9.8
45-54	36	9	25.0	17	1	5.9
55-64	37	11	29.7	6	—	—
65 and over	13	2	15.4	4	2	50
Total	128	22	17.2	107	9	8.4

event reportable in England and Wales, to Her Majesty's Coroner who may order an autopsy and hold an inquest.

For much the same reasons, it is possible, perhaps likely, that even where of minor degree, the presence of asbestosis has tended to be recorded increasingly on the death certificate. From this, it also follows that the increasing total of cases thus identified in recent years may include less severely affected persons who in earlier years, when awareness was less, might have gone unrecognized. Even so, our totals of death certificates recording asbestosis probably represent an understatement rather than a maximum total of persons dying with, as distinct from, asbestosis.

Previously Published Studies by H.M. Factory Inspectorate

Merewether's interest in asbestosis and indeed in the pneumoconioses in general, continued after his original investigations were completed. He was responsible for several publications in the Annual Reports⁴⁻¹⁰ of the Chief Inspector of Factories of data of asbestos deaths with the incidence of carcinoma of the lung in them. The first TABLE is reproduced from the 1947 Annual Report. It is believed that this is the first considerable series suggesting the association to have been analyzed. At that time, an attitude of caution was adopted and no formal claims of any association were made. However, the incidence of 13.2 per cent lung cancers in the total for both sexes of 235 deaths with asbestosis up till then identified, was contrasted with an incidence of lung cancer of 1.32 per cent in 6,884 cases certified at death as having silicosis.

References to this apparent association of asbestosis and bronchial cancer were again published by Merewether in the Annual Reports of the Chief Inspector for the years 1954 and 1955 by which time similar observations had been recorded by other British observers. Table 2 records the position as published in the Annual Report for 1955 when particulars were

TABLE 2
ASBESTOSIS AND CANCER OF THE LUNG AS AT 1955

Diagnosis	Males		Females		Total	
	Number	Percentage	Number	Percentage	Number	Percentage
Asbestosis all cases	222	100	143	100	365	100
Asbestosis and cancer of the lung	48	21.6	17	11.9	65	17.8

TABLE 3
INCIDENCE OF ASBESTOSIS AND LUNG CANCER 1924-1963

Period	Males		Females	
	Asbestosis and	Per cent with	Asbestosis and	Per cent with

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	Number	Percentage
	365	100
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TABLE 3
INCIDENCE OF ASBESTOSIS AND LUNG CANCER 1924-1963

Period	Males			Females		
	All asbestosis	Asbestosis and cancer of the lung	Per cent with cancer of the lung	All asbestosis	Asbestosis and cancer of the lung	Percent with cancer of the lung
1924-1930	13	-	Nil	7	-	Nil
1931-1940	66	13*	19.7	82	5	16.1
1941-1950	92	21†	22.8	45	5*	11.1
1951-1960	144	45	31.3	40	11	27.5
1961-1963	77	42‡	54.5	18	4	22.2
1924-1963	392	121	30.9	192	25	13.0

*Includes one case recorded as "cancer of pleura."

†Includes one case recorded as "sarcoma of pleura."

‡Includes four cases recorded as "mesothelioma of pleura."

held in the Medical Branch of 365 death certificates recording asbestosis. Of these, 65 or 17.8 per cent referred also to the presence of a lung cancer. It will be noted that the proportion with such a tumor had risen in both sexes as compared with 1947, males from 17.2 per cent to 21.6 per cent; females from 8.4 per cent to 11.9 per cent.

The Current Position

We now have, up to the end of 1963, death certificate information concerning 584 deaths, made up of 392 males and 192 females, in which asbestosis has figured. To show the changes over the years more clearly, I have presented in TABLE 3, a complete series of recognized cases in convenient periods of time.

This table clearly indicates how, in recent years, asbestosis in males, but not in females, has been more frequently recorded on death certificates and, of particular significance in the context of this paper, how the proportion of these cases, in which a bronchial carcinoma or other form of primary thoracic tumor has been found to be present, is also increasing. This increase in lung cancer as a complicating feature of asbestosis has occurred in both sexes, although both the actual and the relative incidence of asbestosis in females, as I have remarked, is falling. In the period 1961-1963, no less than 42 of 77 male asbestosis death certificates also recorded a cancer or mesothelioma, a percentage of 54.5, while the corresponding female totals were 4 out of 18, a percentage of 22.2. In the complete series, 30.9 per cent of males and 13 per cent of females have had a lung tumor.

In the analysis of the information available in 1947, it was noted that the mean age of death of asbestotics with a lung cancer was 52.1 years, whereas those dying from asbestosis without such a complication tended to die earlier at a mean age of 44.2 years (TABLE 4). By 1954, however, this difference was less pronounced.

TABLE 5 shows the average age at death of the 584 identified subjects up to the end of 1963. These are arranged according to sex, in three groups, one in which asbestosis was unaccompanied by either tuberculosis (a not uncommon complication in the past) or carcinoma; one in which it was complicated by tuberculosis and a third in which a thoracic cancer was the complicating feature. The primary object in doing this was to ascertain whether the interesting observation noted in 1947 was still evident, and in this respect, the complete data are inconclusive. The table does, however, show in both sexes a lengthening span of life in those with uncomplicated asbestosis, perhaps in part due to identification of less severe cases during life and their ultimate inclusion in death records. Although not within the terms of reference of this paper, I think it is worth remarking that tuberculosis today no longer appears as a complication of significance in either sex. There is a considerable variation in the mean age of death in the

cates recording asbestosis, presence of a lung cancer, a tumor had risen in both per cent to 21.6 per cent;

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cases, asbestosis in males, but on death certificates and, however, how the proportion of other form of primary cancer also increasing. This increase of asbestosis has occurred relative incidence of asbestosis in the period 1961-1963, notes also recorded a cancer in the corresponding female in the complete series, 30.9 per cent had a lung tumor.

In 1947, it was noted that the age at death of cancer was 52.1 years, with a complication tended to be higher. By 1954, however, this

of 584 identified subjects according to sex, in three groups, either tuberculosis (a not rare disease; one in which it was a thoracic cancer was the reason for this was to ascertain whether this was still evident, and the table does, however, show those with uncomplicated asbestosis and less severe cases during the period. Although not within the limits of significance in either sex, the age of death in the

TABLE 4
MEAN AGE AT DEATH, 1947 SERIES

	Males		Females		Total	
	Asbestosis	Asbestosis and lung carcinoma	Asbestosis	Asbestosis and lung carcinoma	Asbestosis	Asbestosis and lung carcinoma
Mean age at death in years	49.2	55.2	38.1	44.6	44.2	52.1
Standard deviation	12.4	5.9	10.1	13.96	16.0	10.3
Range in years	19-77	46-70	22-72	32-71	19-77	32-71

*Average age at death based on 50 cases only.

Period	Males						Females									
	Asbestosis only			Asbestosis + tuberculosis		Asbestosis + intrathoracic cancer		Asbestosis only			Asbestosis + tuberculosis		Asbestosis + intrathoracic cancer			
	Cases	Av. age		Cases	Av. age	Cases	Av. age	Cases	Av. age	Cases	Av. age	Cases	Av. age	Cases	Av. age	
1924-1940	43	49.3		23	44.3		13	55.6		52	39.6*		32	33.7	5	49.0
1941-1950	54	55.9		17	42.1		21	54.3		31	45.2		9	37.6	5	41.2
1951-1960	86	58.1		13	55.3		45	56.4		28	56.7		1	51.0	11	51.0
1961-1963	34	60.4		1	53		42†	57.6		13	57.8		1	54	4	62.5

The data which show the rate of dying from asbestosis is a considerable one and appears to be increasing. There has been a lot of statutory procedure that the amount of compensation for years, and we have a lot of asbestosis are covered by the statutory provisions. There are other instances of people recently dying not covered by the suggested that there should be a greater recognition of the disease.

1951-1960	86	58.1	13	55.3	45	56.4	28	56.7	1	51.0	11	51.0
1901-1963	34	60.4	1	53	42†	57.6	13	57.8	1	54	4	62.5

*Average age at death based on 50 cases only.

†One case also had pulmonary tuberculosis.

female asbestosis with cancer group, where the totals are mostly relatively small. On the other hand, in the large male group with cancer, there has been very little improvement in the average age at death. While initially this group did seem to survive to a greater age than the group with asbestosis only, this is no longer so.

Asbestosis and Mesothelioma

Other authors in this Annal have dealt with mesothelioma of pleura and peritoneum, and adduced evidence that this tumor may be one related in many instances to exposure to asbestos with minimal or no obvious evidence of asbestosis. As the population exposed to asbestos dust, including "neighborhood" groups is not known, it is impossible to give rates of incidence. Mesothelioma has also figured in our own series of deaths in which asbestosis has been diagnosed clinically or pathologically. By comparison with deaths from cancer of the lung or bronchi, such deaths have been infrequent but their significance may be better indicated by expressing them as a percentage of the total number of asbestosis deaths. They have not been distinguished in the TABLES from the other cases of intrathoracic malignant disease except in the footnotes to TABLE 3 from which it will be seen that, in addition to four recently diagnosed occurrences there have been two examples described as "cancer of the pleura" and one as "sarcoma of the pleura." If one assumes that all seven cases were in fact mesotheliomas, the proportion turns out to be 1.2 per cent or, in males only, 1.5 per cent.

Our records incidentally have also indicated the occasional occurrence of cancer of the ovary, "abdominal" cancer, or "malignant peritonitis" and the suspicion that some such cases may have been mesothelioma of the peritoneum arises. In all, there have been eight such cases.

Discussion

The data which I have presented suggest that the risk in Great Britain of dying from an intrathoracic tumor if asbestosis is present, is a considerable one and affects both sexes, although not equally. It also appears to be increasing. This, if true, is a disturbing state of affairs especially as there has been in operation for upwards of 30 years a stringent system of statutory precautions for the traditional uses of asbestos. It is a fact that the amount of asbestos used annually has increased greatly over the years, and we have some evidence from other sources that the victims of asbestosis are to a greater extent in those industries not directly affected by the statutory precautions. It is well therefore, to consider whether there are other important influences operating which result in those currently dying not being comparable to those of earlier years. I have already suggested that the increasing totals of recent years may in part be due to a greater recognition of cases which might truly be described as dying

"with" in contrast to "from" asbestosis. There may be a tendency to perform an autopsy examination of anyone dying from any chest complaint who, in the past, had worked in an asbestos factory. Certainly by now there must be a general awareness of asbestosis as an occupational hazard in the neighborhood areas of the principal asbestos-using factories. By such a means, in view of current compensation policies, a lung cancer might become related in death certification to a relatively minor degree of asbestosis without the latter necessarily being in any way causal.

Study of information on death certificates relating to a particular disease cannot, in the absence of information concerning the size of the population at risk, give any worthwhile information on attack rates. There is also an increasing incidence of lung cancer in the population as a whole, and other influences, such as cigarette smoking, no doubt also operate in asbestotics. Nevertheless, the proportion of males in the whole series in whom lung cancer was present amounted to 30.9 per cent, and of females, to 13.0 per cent, whereas by contrast, in 1962,¹¹ which year represents the highest incidence yet published, in the general population 7.5 per cent of deaths in males of 20 years and upwards were due to primary lung or bronchial cancer and 1.4 per cent in the case of females. It is also worth noting that the ratio of the percentage of male asbestotics dying with a lung tumor to the corresponding female series is only 2.4 to 1 compared with a corresponding ratio in the general population in 1962 of 5.4 to 1.

The data suggest that in contrast to the improving longevity of those with asbestosis alone, there is little improvement in the age at death of those also affected with a cancer. This would suggest that cancer is a complication usually, although by no means always, of long latent period, greater on average than the mean period of survival from first exposure of those severely affected by the asbestosis of earlier years but within the normal period of survival of the less severely affected of today. This might be a further explanation of the growing proportion of such cases dying of lung neoplasm.

All said, it seems beyond dispute that in Great Britain, there is a greater risk of dying from intrathoracic tumor if asbestosis of the lungs is present.

Summary

The findings of a continuing study by the Medical Branch of H.M. Factory Inspectorate, Ministry of Labour, of information recorded on death certificates of persons dying with asbestosis are presented. Arrangements are in force whereby copies of all such certificates are received routinely by the Medical Branch. It is considered, for reasons outlined, including the high proportion of such cases coming to autopsy, that this method is a reasonably accurate one of assessing both the incidence of all recognized cases as asbestosis and of complications ensuing.

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A review of the literature indicates that the possibility of carcinoma of the lungs or bronchi as a complication had been expressed prior to 1947. Nevertheless, it is believed that the first series in which the incidence of lung carcinoma had been related to a sizeable group of asbestosis deaths was that published in the 1947 Annual Report of the Chief Inspector of Factories. Similar reports followed in 1954 and 1955.

Up to the end of 1963, 584 death certificates recording the presence of asbestosis have been obtained and the annual totals of such certificates are currently increasing. The proportion recording a thoracic tumor is also in both sexes continuing to increase disproportionately to the total number, so that currently over 50 per cent of males dying with asbestosis present have also a neoplasm. Data on the mean age at death over various periods of time of male and female asbestosis cases indicate an improving prognosis where the asbestosis is uncomplicated but no significant improvement where complicated by cancer. Suggestions to account for this and also the yearly increasing total of recorded cases of asbestosis are put forward. The conclusion of the study is that even when viewed against the steadily rising incidence of lung cancer in the population as a whole, there seems little doubt that there is a special risk of an intrathoracic tumor if asbes-
tosis is also present in the lungs.

Acknowledgments

I would like to record the debt due to my colleague G. O. Williams who, over the years, has been responsible for the abstraction of the information on which the data presented are based. I wish also to thank Dr. Williams for helpful criticism and Dr. T. A. Lloyd Davies, H.M. Senior Medical Inspector of Factories and the Ministry of Labour for permission to present this paper.

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