Validation of death certificates in asbestos workers

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Newhouse, M. L., and Wagner, J. C. (1969). *Brit. J. industr. Med.*, **26**, 302-307. **Validation of death certificates in asbestos workers.** The Registrar General has supplied the certified cause of death of 436 past workers in an asbestos factory. An attempt was made to follow up the 301 (69%) deaths which had occurred in hospital or had been the subject of an inquest or coroner's post-mortem examination. Necropsy reports were obtained for 158 (52%) of this group and histological material was reviewed in 84 (28%). The additional information, particularly that obtained from review of the histology, led to the revision and extension of the diagnosis suggested by the certified cause of death in a number of cases. The incidence of carcinoma of the bronchus had not been grossly underestimated, four additional tumours of this type were identified by scrutiny of the necropsy reports, and a further four by review of histological sections. The incidence of mesothelial tumours was underestimated, endothelioma or mesothelioma was the certified cause of death in four of the series, and a further 15 mesotheliomata were identified by review of histological material. Five patients with pleural mesotheliomata had been certified as dying of carcinoma of the lung or pleura. Ten deaths from peritoneal mesotheliomata had been attributed either to carcinomatosis without mention of a primary tumour or to cancer of the gastro-intestinal tract. Lung sections were submitted for review in 67 of the series; some degree of asbestosis was found in all but seven. Asbestosis graded as either moderate or severe was found in all the confirmed cases of carcinoma of the lung.

There are considerable discrepancies between the certified cause of death and the pathological conditions revealed at necropsy (Heasman and Lipworth, 1966). During the course of a cohort study of workers at an asbestos factory (Newhouse, 1969) 436 copies of the death entry were obtained from the Registrar General. It was necessary to use the certified cause of death for comparison with the national figures in the statistical analysis of mortality, but a further investigation has been undertaken in order to validate the cause of death in as many cases as possible and to make an estimate of the incidence of mesothelial tumours, cancer of bronchus, gastro-intestinal tumour, and pulmonary asbestosis.

Method

As well as the actual cause of death and the contributing factors, the death entry also states the place of death and whether there was a coroner's inquest or post-mortem examination ordered by the coroner. It was thought unlikely that men dying at home would have been the subject of a necropsy, therefore the deaths selected for follow-up were the 215 who had died in hospital, and the 86 who died at a private address but had been the subject of an inquest or coroner's post-mortem examination.

Sixty-nine different hospitals were involved and a few of these had ceased to exist or had changed their function, but a considerable number of workers in the series had died at the London Hospital, Old Church Hospital,

Romford, and other hospitals in the East End of London. Lists of patients dying in each hospital were prepared and the hospitals were contacted to find if necropsies had been held on any of the patients. If the post-mortem report was available, the hospital was requested to send a copy to the authors. Later the pathologist who made the examination was asked if he would loan material for histological review.

A similar procedure was adopted for the coroners' cases, and five London coroners and 16 outside London were contacted. One London coroner permitted us to search among his considerable store of records. After receiving a copy of the necropsy report the coroner's pathologist was asked for permission to re-examine his histological preparations.

It was known that some of the men in the series selected for follow-up had been certified as suffering from asbestosis during life. The names of all in the series were checked against the records of the London Pneumoconiosis Medical Panel. These records have been kept from 1955, and it has been the custom to preserve the lungs for future examination in deaths certified as being due to asbestosis.

Results

No further information was obtained about 143 of the deaths, but necropsy reports alone were obtained for 74 (24.6%) and necropsy reports and histological material for review in a further 84 (27.9%) of the series (Table 1). The London Pneumoconiosis Medical Panel contributed 47 of the post-mortem reports and histological material in 44 of the cases (Table 2). Frequently information was obtained from both the hospital where death occurred and from the Panel.

It was difficult to obtain either necropsy reports or pathological material for deaths that occurred before 1955; 13 post-mortem reports were received with earlier dates than this, but pathological material was available for only three.

Series 1 - Necropsy report only

Thirty of the 74 necropsy reports in this series were obtained from coroners; 16 of them related to violent

TABLE 1
NUMBER OF NECROPSY REPORTS AND PATHOLOGICAL SPECIMENS RECEIVED

Place of death	Series 1 Necropsy report only	Series 2 Necropsy report and histology	No further information
Hospital (± Inquest)	54	65	95
Private address (Coroner's inquest/P.M.)	20	19	48
Total	74 (24.6%)	84 (27.9%)	143 (47.5%)

TABLE 2
SOURCES OF INFORMATION

Source	Series 1 Necropsy report only	Series 2 Necropsy report and histology
Hospital records	39	30
Coroner's record	30	9
London Pneumoconiosis Medical Panel	3	44
Other	2	1
Total	74	84

deaths, such as accident, suicide or poisoning, to sudden death from cardiovascular accidents, such as ruptured aortic aneurysm and coronary thrombosis, and a few to post-operative deaths (Table 2). In such cases, histological sections from the lungs are rarely taken. Three of the necropsy reports came from the London Pneumoconiosis Medical Panel; a report on the histology of the lung was included which in all three confirmed the diagnosis of asbestosis, but sections were no longer available for review.

There were four additional cancers of the lung revealed by necropsy reports (Table 3) - two where the certified cause of death was bronchopneumonia, one asbestosis, and one carcinomatosis. Another certificate gave the cause of death as secondary carcinoma of the lung, while the necropsy revealed a retroperitoneal sarcoma. There was one death certified as due to mesothelioma of the peritoneum; the post-mortem report was incomplete, but a report on the histology of the tumour states that the changes are those of 'endothelioma of the mesentery'. Histological specimens of the tumour had not been preserved.

Series 2 - Necropsy reports and histological material

The London Pneumoconiosis Medical Panel and the London Hospital were the most important sources in this series; they contributed material from about two-thirds of the cases reviewed (Tables 1 and 2).

Deaths registered as carcinoma of lung with or without asbestosis Carcinoma of the lung was the certified cause of death in 29 of this series (Table 4). On 17 of these certificates asbestosis was mentioned as the associated or underlying cause of death. Review of the histological material confirmed the presence of a bronchial carcinoma in 24; in five the tumour was reclassified as a pleural mesothelioma.

Among these 24 confirmed cases of bronchial carcinoma, nine were classified as adenocarcinoma, five as squamous cell, five as oat cell, and the remainder as anaplastic, undifferentiated or polygonal celled.

TABLE 3
 SERIES 1: REVISION OF 'CAUSE OF DEATH' AFTER SCRUTINY OF NECROPSY REPORT

<i>Disease category</i>	<i>No. certified</i>	<i>No. added</i>	<i>No. removed</i>	<i>Revised no. in category</i>
(1) Cancer of lung with or without asbestosis..	10	1 from Cat. (2) 2 from Cat. (3) 1 from Cat. (5)	0	14
(2) Asbestosis without tumour	6	0	1	5
(3) Other respiratory diseases	7	0	2	5
(4) Peritoneal mesothelioma	1	0	0	1
(5) Other tumours	4	0	1	3
(6) Other diseases.. .. .	46	0	0	46

TABLE 4
 SERIES 2: REVISION OF 'CAUSE OF DEATH' AFTER SCRUTINY OF NECROPSY REPORT AND REVIEW OF
 HISTOLOGICAL MATERIAL

<i>Disease category</i>	<i>No. certified</i>	<i>No. added</i>	<i>No. removed</i>	<i>Revised no. in category</i>
(1) Cancer of lung with or without asbestosis..	29	3 from Cat. (2) 1 from Cat. (4)	5	28
(2) Asbestosis without lung tumour	15	0	3	12
(3) Gastro-intestinal tumours	14	0	7	7
(4) Other tumours	10	0	4	6
(5) Mesothelioma				
Pleural	1	5 from Cat. (1)	0	6
Peritoneal	3	7 from Cat. (3) 3 from Cat. (4)	0	13
(6) Other diseases.. .. .	12	0	0	12

In this small series of carcinoma of the bronchus, as far as could be ascertained from the available material, all the cases occurred in association with marked or moderate asbestosis.

Asbestos bodies (the number graded from few to numerous) were found in 22 of the 24 sections of lung tissue examined.

Deaths registered as asbestosis Asbestosis was the certified cause of death in 12 of the deaths included in this group. In three others it was given as the underlying cause of death, in which the certified causes were duodenal ulcer, myocardial fibrosis, and bronchopneumonia. Carcinoma of the bronchus was found at necropsy in each and was confirmed by review of the histology.

Cor pulmonale was the mode of death in five in this group; in each of these the necropsy reports mention gross thickening of the pleura or severe pleural adhesions.

One of the cases illustrates the difficulty of final diagnosis. A man aged 52 had an open biopsy for a markedly thickened pleura, the features of which were considered to be suggestive of malignancy. He died a few weeks after discharge from hospital; a coroner's necropsy was done and his thoracic organs were submitted to the Pneumoconiosis Panel. The hospital pathologists decided that the biopsy material showed evidence of markedly hyperplastic pleural tissue but that it was not malignant, the most suspicious material coming from nodules on the posterior chest wall. The coroner's pathologist found

evidence of asbestosis, cor pulmonale, and dense fibrosis of the pleura. The consultant pathologist to the Pneumoconiosis Panel reported similarly on the thoracic organs. Review of these histological preparations confirmed their findings. However, re-examination of the biopsy material showed the presence of highly suspicious tissue suggestive of a mesothelioma. These sections were submitted to four members of the British Mesothelioma Panel; two diagnosed a mesothelioma and two hyperplastic fibrous tissue (not malignant). A further four British pathologists had equally divided opinions. Finally, the sections were shown to a member of the South African and a member of the American Panels; once again opinion was divided. Figures 1 and 2 show one of the controversial areas. No sections were available from the posterior chest wall at the time of the post-mortem examination, so it is probable that a final diagnosis will never be reached. In this study it has been classified as a case of severe asbestosis with gross pleural thickening.

Deaths registered as gastro-intestinal tumours and

other malignant tumours There were 14 deaths certified as due to a primary growth of the gastro-intestinal tract; usually carcinomatosis was given as the underlying cause of death. Seven of the tumours in this group were reclassified as peritoneal mesothelioma. In this group the presence or absence of asbestosis could not be judged as lung tissue had not been preserved.

Four deaths were certified as due to carcinomatosis without mention of a primary tumour; in three the tumour was reclassified as a peritoneal mesothelioma and in one as a rhabdomyosarcoma. Two tumours were confirmed as lymphomata. A cerebral tumour was identified as a secondary growth from an adenocarcinoma of the lung.

Mesothelial tumours identified Tumour tissue was available from the necropsies of all four of the subjects whose deaths had been certified as due to endothelioma or mesothelioma, and a review of the histology confirmed the diagnosis. Including the two published cases not personally reviewed (Enticknap and Smither, 1964), there were 19 mesothelial

FIG. 1. Biopsy section from chest wall with markedly thickened pleura suggestive of mesothelioma (see text). $\times 100$.

FIG. 2. The same as in Fig. 1. $\times 400$.

tumours identified among the 84 deaths in this series. In seven the certified cause of death related to the gastro-intestinal tract (Table 5), in five the certified cause was cancer of the lung or bronchus, and in three carcinomatosis. Carcinoma of the tonsil appeared on one death certificate. The patient had

had a tonsillectomy, following which the diagnosis had been made, but later he died from a widespread peritoneal tumour. All pathologists who have reviewed the sections, including the one who performed the post-mortem examination, agree that the histological appearances are consistent with a mesothelioma.

Asbestotic changes and asbestos bodies were found in specimens of lung tissue from eight of the necropsies; in the remainder, lung sections had not been preserved.

TABLE 5
CERTIFIED CAUSES OF DEATH OF MEN DYING OF
MESOTHELIAL TUMOURS

Category	Certified cause of death	No.
Pleural	Endothelioma of pleura	1
	Carcinoma of lung	5
Peritoneal	Mesothelioma/endothelioma of mesentery	3
	Carcinomatosis	3
	Carcinoma of pancreas	3
	Carcinoma of rectum	2
	Carcinoma of gall bladder	1
	Carcinoma of tonsil	1

Respiratory and other diseases not associated with neoplasm Four of the deaths were certified as being due to pneumonia, and one to chronic pulmonary tuberculosis; a minor degree of asbestosis and few asbestos bodies were found in the specimens of lung from the four deaths from pneumonia but not in the sections of lung from the necropsy on the case of tuberculosis. One death was certified as chronic nephritis and six as cardiovascular disease. Specimens of lung tissue were available for all seven; in four, minor degrees of asbestosis were noted.

Discussion

The deaths in which it had been possible to obtain information additional to the death certificate are not representative of all the deaths occurring among past workers at this asbestos factory. In the first series, 30 of the necropsy reports were obtained from the coroners, part of whose function it is to investigate the cause of violent or sudden death. The second series is heavily weighted by the 44 post-mortem reports, accompanied by material for histological review, received from the London Pneumoconiosis Medical Panel. These reports are related to men who had been certified as suffering from asbestosis during life, or where it was believed that compensation for asbestosis could be claimed after death.

The majority of the workers in whom it had been possible to review the cause of death had been employed for long periods at the factory. Where the worker had been employed in the factory for a short period many years previously, it was more difficult to obtain information additional to the death certificate. Also the deaths investigated were chiefly those occurring between 1955 and 1964, a period when it is known that the incidence of mesothelial tumour was rising (Gilson, 1966).

The prevalence of carcinoma of the bronchus was not greatly underestimated in either series. Four (5.4%) additional tumours of this type were identified in the first series, and four (4.7%) in the second. The prevalence of mesothelial tumour was underestimated. In the whole series of 436 deaths, mesothelioma or endothelioma was given as the cause of death on seven certificates. Fifteen additional mesotheliomata were identified by a study of the histological material from the 84 necropsies in the second series. The pathological appearances were frequently confused with a generalized carcinomatosis of the peritoneum, where the primary tumour was either undiagnosed or believed to be in the gastro-intestinal tract. In five of the necropsies pleural mesothelioma was not differentiated from carcinoma of the bronchus.

The degree of asbestosis present in these cases has been judged on the available histological material. This has probably resulted in an overestimation, and the diagnosis has not been revised in Table 4. The working party on asbestos and cancer (Recommendations on Pathology and Experimental Pathology, 1965), recommended that the severity of

asbestosis could be best estimated if both lungs were examined macroscopically and that representative sections should be taken, at least six blocks of lung tissue being required. In the majority of cases in this study only one section from the lungs has been received. In general, pathologists tend to take sections of the most significant lesions from the various organs. Therefore, it is likely that if only one section has been taken from the lungs this will probably include the most fibrotic area, which may not be representative of the lungs. If the available evidence is accepted, asbestosis was found in 60 out of the 67 (90%) in which at least one section of lung tissue was submitted. In 53 the degree of asbestosis present was graded as moderate or severe.

The 84 deaths studied in the greatest detail included the 44 known to the London Pneumoconiosis Medical Panel. These were the factory workers who were judged in life to be the most severely affected by exposure to asbestos dust. There were 40 other deaths included in the series where necropsies had been performed and pathological material preserved for a variety of reasons unconnected with the workers' occupation during life.

Among the 84 deaths fully reviewed a malignant neoplasm was found in 60 (71%). These have been reclassified on review as carcinoma of the bronchus in 28 (33%), mesothelioma in 19 (22%), gastro-intestinal tumour in seven (8.3%), and other tumours in six (7%).

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