



## Mesothelioma Among Machinists in Railroad and Other Industries

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The first phase of the exploration of occupation-related cancer among machinists was a retrospective review of deaths among members of the International Association of Machinists and Aerospace Workers in 1973, in which mesotheliomas were identified in workers in railroad and other industries. The second phase of the study initiated in 1982 was the establishment of a cohort study of machinists, employed for railroad company A, who were alive in January 1954. The cohort consisted of 197 machinists who had been employed by the same railroad prior to 1935 and observed to 1982. Causes of death were identified for 132 of the cohort. There were 18 alive and 47 not traced. Among the 29 cancer deaths, there were nine mesotheliomas and one endothelioma of the pleura.

Additional retrospective surveys of deaths among members of the railroad lodges of the international union, together with the cohort study, identified a total of 42 mesotheliomas, two endotheliomas of the pleura, and two cancers of the pleura among former railroad machinists.

Among the machinists employed in other industries, 16 mesotheliomas and six cancers of the pleura were identified.

For decades, machinists, by the nature of their craft, have had a high risk of occupation-related cancer due to asbestos exposure.

**Key words:** cohort, epidemiological, mesotheliomas, machinists, railroad, asbestos, steam locomotive, crafts, industry

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### INTRODUCTION

For decades prior to the New York Academy Symposium on Biological Effects of Asbestos in 1964, investigators had studied workers exposed to asbestos in diverse industries and occupational situations and had reported on asbestosis, cancer of the lung, cancer of the pleura, mesothelioma of the pleura and peritoneum, and other cancer and noncancer effects. During the course of these investigations, asbestos exposure from insulation and insulation-type work was identified and recognized as

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This paper was presented in part at the Medical Conference of the Association of American Railroads' 62nd Annual Meeting, May 13, 1982, Pittsburgh, PA.

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Accepted for publication January 25, 1983.

an important occupation-related cancer risk among these workers [Russell, 1932; Ellman, 1934; Kuhn, 1940; Holleb and Angrist, 1942; Fleischer et al, 1946; Kennaway and Kennaway, 1947; Mallory et al, 1947; Franchini and Canepa, 1949; Frost, 1950, 1956; Stoll et al, 1951; Weiss, 1953; Breslow, 1955; Hampe, 1956; Ahlborg et al, 1956; Mofino and Zannini, 1956; Pendergrass, 1958; Van der Shoot, 1958; Hertz and Reinwein, 1959; Anderson and Campagna, 1960; Ahlmark et al, 1960; Keal, 1960; Wagner et al, 1960; Eisenstadt and Wilson, 1960; Heard and Williams, 1961; Frankel and De Jager, 1961; Sleggs et al, 1961; Eisenstadt, 1962; Cordova et al, 1962; McCaughey et al, 1962; Bogetti, 1963; Castleman and Knowles, 1963; Farina and Mazzanti, 1963; Leathart and Sanderson, 1963].

Selikoff, from 1964 on, provided in succeeding years the broadest continuous emphasis on insulators as a high-risk group for occupation-related cancer in a major series of investigations that demonstrated a wide range of cancer effects for asbestos-exposed workers [Selikoff, 1964, 1981; Selikoff et al, 1964, 1965a,b].

The purpose of the present paper is threefold: first, to emphasize machinists as another important occupational group exposed to asbestos in diverse industries with an increased risk of cancer effects; second, to present the findings of mesotheliomas observed among machinist railroad workers; and third, to provide descriptive background on occupational exposure to asbestos in the railroad industry as a point of reference for subsequent investigative reports.

The findings provide striking evidence and continued confirmation of a basic fact that has been known for decades: Increased cancer risk occurs wherever the exposure to asbestos exists, regardless of the job title, job assignment, or location of the exposure.

The present paper includes the first epidemiological cohort study of machinists who were exposed to asbestos in the railroad industry during the early years of the steam locomotive.

## MATERIALS AND METHODS

The first phase of the epidemiological exploration of occupational cancer among machinists, conducted in 1973, was a retrospective review of the causes of death reported during 1966-1971 among members of the International Association of Machinists and Aerospace Workers, together with computer listings from the research department on industrial employment classifications. In this process there were eight mesotheliomas identified among machinists employed in the railroad and five among those who worked in other industries [Mancuso, 1975, 1976]. Death claims filed with the international union for death benefits served as the basis of information on causes of deaths. Information about working conditions was obtained from former railroad workers who had been members of the international union. Where possible, microscopic slides of tissue specimens were obtained and sent to Dr Christopher Wagner for histological review in 1973. Six asbestos samples were obtained from old locomotives which had been sitting in railroad shops for 30 or more years. These samples of asbestos were subjected to electronic microscopy and microprobe analysis in 1975 by Dr E.D. Pooley. Two were identified as chrysotile only and four as amosite. Efforts to obtain additional samples were deferred.

The second phase of the epidemiological study began in 1982 when a 1954 seniority list was found of railroad machinists employed by the same railroad. A

TABLE 1. (1966-1971) Mesothelioma Among Railroad Machinists

| Year of death | Age at death | Death certificate information and histological review                           | Hospital records                                                                                                                                                                                                                       |
|---------------|--------------|---------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| (1) 1966      | 71           | Mesothelioma, left pleura                                                       | Autopsy—mesothelioma of left pleural cavity and adenocarcinoma of right kidney (2 primary tumors)<br>Operation—biopsy—Hospital Records: extensive pleural tumor with involvement of right diaphragm<br>Autopsy<br>First diagnosed 1966 |
| (2) 1970      | 68           | Mesothelioma, right pleura<br>Wagner—mesothelioma of mixed type                 |                                                                                                                                                                                                                                        |
| (3) 1970      | 78           | Mesothelioma, left pleura                                                       |                                                                                                                                                                                                                                        |
| (4) 1970      | 75           | Adenocarcinoma of left pleura<br>Wagner—mesothelioma of epithelial type         |                                                                                                                                                                                                                                        |
| (5) 1970      | 62           | Pleural adenocarcinoma of right chest<br>Wagner—mesothelioma of epithelial type | Operation—biopsy—adenocarcinoma parietal plug<br>No other information                                                                                                                                                                  |
| (6) 1971      | 72           | Mesothelioma, right pleura                                                      | No other information                                                                                                                                                                                                                   |
| (7) 1971      | 71           | Pleural mesothelioma                                                            | Also had chronic lymphatic leukemia—biopsy—(an aplastic malignancy most likely mesothelioma)                                                                                                                                           |
| (8) 1971      | 71           | Pleural mesothelioma<br>Wagner—mesothelioma                                     |                                                                                                                                                                                                                                        |

TABLE VI. Mesothelioma Among Machinists by Age and Year of Death Total Railroad 44, Other Industries 16\*

| Year of death | Age                          |
|---------------|------------------------------|
| 1946          | 67 <sup>a</sup>              |
| 1950          | [47]                         |
| 1953          | [44]                         |
| 1954          | 50                           |
| 1957          | 62                           |
| 1958          | [68]                         |
| 1959          | 58                           |
| 1960          | [44]                         |
| 1962          | 66, 61 <sup>a</sup>          |
| 1963          | 67                           |
| 1965          | [60]                         |
| 1966          | 71                           |
| 1967          | 72 [55]                      |
| 1968          | 65 [56]                      |
| 1969          | 65 [66] [58]                 |
| 1970          | 68, 78, 75, 62 [69] [57]     |
| 1971          | 72, 71, 71                   |
| 1972          | 64                           |
| 1974          | 80 [77]                      |
| 1975          | 65, 73, 84                   |
| 1976          | 74, 72, 75, 85, 70           |
| 1977          | 74, 73, 78, 69 [76] [67]     |
| 1978          | 79, 54, 75, 78, 65 [68] [63] |
| 1979          | 73, 76                       |
| 1980          | 57                           |
| 1981          | 65, 71, 70, 83               |

\*Other industries in brackets.

<sup>a</sup>Endothelioma.

## DISCUSSION

Other investigators have observed mesotheliomas among railroad workers, primarily installators. Wagner et al [1960] reported pleural mesothelioma in two workers that lagged locomotive boilers with asbestos in South Africa and demonstrated that the cancer risk existed wherever the exposure to asbestos occurred. Cochrane and Webster [1978] continued the observation in South Africa and reported 12 mesotheliomas among workers who applied insulation to boilers in the locomotive workshop. Mostert [1979] reported further on asbestosis and mesotheliomas among

factor of total plant and industry studies. Finally, long periods of observation, far beyond what has usually been done in occupation-related cancer epidemiological studies is essential. The findings of this study add to the growing realization that the true nature and extent of the occupation-related cancer problem has not been adequately recognized in the past and evidently has been underestimated.

## ACKNOWLEDGMENTS

This study was made possible through the excellent cooperation and assistance of the officers, staff, and members of the International Association of Machinists and Aerospace Workers, Mr William W. Winpisinger, president.

I wish to express my appreciation to Dr F.D. Pooley, Department of Mineral Exploitation, University College, Cardiff, England, for the analysis of asbestos samples and to Dr Christopher Wagner, formerly of Medical Research Council Pneumoconiosis Unit, Penarth, England, for the histological review of the tissues of the mesothelioma cases. Their professional assistance has been most helpful.

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