Pseudomesotheliomatous lung carcinoma: a pathological assessment of selected cases including the work history and presence of biomarkers suggesting it is a cancer caused by asbestos

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Abstract

Background: We report a series of 196 cases of pseudomesotheliomatous neoplasms identified in one of our laboratories between 1983 and 2015. We also performed an extensive review of the literature. Most “pseudomesotheliomas” arise in the pleural tissue of the chest cavity and resemble pleural mesotheliomas, macroscopically and histologically, although some metastasize to the pleura from another site or can metastasize to other parts of the body.

Methods: The criteria for inclusion as a pseudomesotheliomatous neoplasm were: 1) presentation of the tumor as a diffuse pleural neoplasm confirmed radiographically, by video-assisted thoracoscopy, by thoracotomy, or at autopsy; 2) lack of a tumor outside of the lung/chest cavity; and 3) the microscopic, histologic, histochemical, immunohistochemical, and/or ultrastructural features of the neoplasm other than a mesothelioma, or a neoplasm other than a mesothelioma that showed histologic, histochemical, immunohistochemical features of a specific neoplasm.

Results: Of the 196 patients in our series, 183 were primary in the lung, 2 were primary in the peritoneum, and 11 were metastatic from another site. One hundred thirty-four (68.3%) had a known history of exposure to asbestos (130 occupational and 4 bystander/paraoccupational). Six (6) had no history of exposure to asbestos; and in 56 cases, the exposure history was unknown. Of the 196 cases, 109 (55%) had a history of cigarette smoking, 23 were nonsmokers, and in 64 cases the smoking history was unknown. Of the 196 cases of pseudomesotheliomatous neoplasms arising in the lung/pleura and peritoneum, 134 (68.3%) had historical exposure to asbestos in the workplace or as a result of paraoccupational and/or bystander exposure; 100 (51%) had radiographic and/or pathologic evidence of pleural plaques or pathologically definable asbestosis; and 56 of 59 cases evaluated for ferruginous bodies and/or asbestos fibers had above background levels in digested lung tissues.

Conclusions: We conclude there is a relationship between the development of pseudomesotheliomatous lung cancer and asbestos exposure based on radiological/pathological findings (including tissue burden of ferruginous bodies and/or uncoated asbestos fibers) as correlated with a background history in many individuals within this study.

Keywords: Pseudomesotheliomatous lung cancer, asbestos, cigarette smoke, asbestosis, fiber analysis

Introduction

The purpose of our article is to report on the clinical and pathologic features of pseudomesotheliomatous lung cancer

and to determine if there is a causal relationship between asbestos exposure and/or cigarette smoking. Most cases of pseudomesotheliomatous lung cancer are diagnosed clinically

as mesotheliomas, but when the tissue is further evaluated by histochemistry, immunohistochemistry, and/or electron microscopy, the pathologic findings indicate these tumors are not mesotheliomas but are, in fact, primary lung cancers or metastatic cancers growing in a distribution that macroscopically resembles mesothelioma. The criteria for including a case as a pseudomesotheliomatous neoplasm in our study were: 1) presentation of the tumor as a diffuse pleural neoplasm confirmed radiographically, by video-assisted thoracoscopy, by thoracotomy, or by autopsy; 2) lack of a tumor outside of the lung or chest cavity; and 3) the microscopic, histologic, histochemical, immunohistochemical, and/or ultrastructural features of the neoplasm other than a mesothelioma, or a neoplasm other than a mesothelioma that showed histologic, histochemical, immunohistochemical features of a specific neoplasm. Some pseudomesotheliomatous lung cancers represented metastatic cancers from a site outside of the chest that grew in a diffuse pleural distribution macroscopically mimicking a diffuse pleural mesothelioma. We also performed an extensive review of the literature concerning pseudomesotheliomatous lung cancers, which are summarized in [Table 1 \[1-40\]](#).

Materials and methods

Tissue samples were evaluated in 196 individuals who were diagnosed as having pseudomesotheliomatous neoplasms (194 pleural; 2 peritoneal). These neoplasms were received during the normal course of business by Diagnostic Specialties Laboratory, Inc., P.S., Bremerton, Washington (laboratory of Samuel P. Hammar, M.D.) between 1983 and 2015. These materials were considered discarded at the time of our study. No name identifiers were used. Of the 196 cases, thirty (30) were medical consultation cases; fourteen (14) were surgical cases from Harrison Medical Center, Bremerton, Washington; and 152 were medico-legal cases which were sent to one of our laboratory's (SPH) for possible asbestos-related litigation. Most were subtypes of primary pulmonary adenocarcinoma and other non-mesothelial cancers. When indicated, histochemical studies were performed on 4 µm thick sections for Periodic acid-Schiff (PAS), PAS-diacetate, mucicarmine, and Alcian blue with and without hyaluronidase according to standard techniques. Immunohistochemical studies were performed on paraffin embedded tissue, if available, according to standard techniques using the Ventana Bench Mark System®. Positive and negative controls were run for each test performed. Because these cases involved diffuse malignant pleural mesothelioma in the differential diagnosis, a combination of positive and negative markers were used for differentiating epithelial mesothelioma from primary pulmonary adenocarcinoma. The antigens most commonly used as positive markers for epithelial mesothelioma (negative markers for primary pulmonary adenocarcinoma) were calretinin, cytokeratin 5/6, cytokeratin 7, mesothelin, D2-40 (podoplanin), and HBME-1. The most commonly used positive markers for

primary pulmonary adenocarcinoma (negative markers for epithelioid mesothelioma) were carcinoembryonic antigen (CEA), LeuM1 (CD15), thyroid transcription factor-1 (TTF-1), B72.3 and BerEP4. In the event that ultrastructural evaluation was required to aid in the diagnosis, tissue specimens were fixed in Trump's fixative and in some instances neutral buffered formalin. In rare instances, tissue was removed from paraffin blocks and processed for ultrastructural evaluation.

In cases where formalin-fixed autopsy tissue was available, 5-gram samples of peripheral lung tissue were cut into small pieces and completely digested in commercial bleach at Diagnostic Specialties Laboratory in Bremerton, Washington. After complete digestion, the bleach was carefully decanted and the sediment at the bottom of the container was carefully extracted with equal volumes of chloroform and 50% ethyl alcohol. This solution was transferred to a test tube, shaken vigorously, and centrifuged at 1200 revolutions per minute (rpm) for ten minutes. After removal of as much carbonaceous material as possible, the solution was re-centrifuged and the sediment at the bottom of the test tube was extracted in 95% alcohol and passed through a Millipore filter of 0.5 micrometer diameter pore size. Ferruginous bodies (morphologically consistent with the appearance of asbestos-cored ferruginous bodies) on the filter were then counted. In our laboratories (SPH, RFD), persons in the general population may have between 0-20 asbestos bodies per gram of wet lung tissue, which we consider to be background levels [41].

Formalin-fixed lung tissue from 20 cases was submitted to the Tyler laboratory (Ronald F. Dodson's laboratory) and prepared for evaluation via a digestion procedure using a modified bleach procedure [42]. The extensive findings from this evaluation were published in a companion manuscript [43]. A synopsis of the methodology used was: "Dry weights were calculated based on a dry/wet ratio obtained for each digestion pool. All reagents were pre-filtered through 0.2 µm pored polycarbonate filter prior to use in the digestion procedure. Control blanks of filters and solution blanks were prepared and evaluated to provide quality assurance within the laboratory. Aliquots of the digestate from each sample were collected on 0.22 µm pored mixed cellulose ester filter for quantitation of ferruginous body content of the tissue samples, while additional aliquots were collected on 0.2 µm pored polycarbonate filters and prepared for evaluation by Analytical Transmission Electron Microscopy (ATEM) for the determination of uncoated asbestos fibers and assessment of core materials of any ferruginous bodies found in the areas evaluated. The preparation of the mixed cellulose filters used for determination of ferruginous body content of the tissue consisted of mounting a wedge of each filter on a glass slide, exposing the filter to acetone vapor (making the substrate transparent) and evaluation of the 'cleared' surface at 100x with magnification increased to 400x via a light microscope if additional morphological clarification was desired. Structures conforming to the definition of a ferruginous body as seen by light microscopy

Table 1. Summary of peer-reviewed journal articles of pseudomesotheliomatous neoplasms.

References	Age Range	Sex	Histologic Type	Occupation	Asbestos exposure?	Tobacco use?
[1]	43-68	M (3) F (2)	Adenocarcinoma (3); Small cell lung cancer (2)	Unknown (5)	Unknown (5)	Unknown (5)
[2]	49-76	M (6)	Bronchiolar adenocarcinoma (5); Adenocarcinoma, poorly differentiated (1)	Shipyards worker WWII (1) Unknown (5)	Yes (1) Unknown (5)	Yes (5) Unknown (1)
[3]	55	M (1)	Adenocarcinoma, tubulodesmoplastic type	Unknown	No	Yes
[4]	65	M (1)	Adenocarcinoma, tubulodesmoplastic type; mucin-producing	Unknown	Unknown	Unknown
[5]	59-80	M (2)	Bronchiolar carcinoma with metastasis to brain, adrenal glands, and liver (1); Adenocarcinoma, mucinous papillary (1)	Unknown (2)	Unknown (2)	Yes (1) Unknown (1)
[6]	56	M (1)	Adenocarcinoma, poorly differentiated	Unknown	No	Yes
[7]	69	M (1)	Bronchoalveolar carcinoma	Blacksmith in an iron foundry	Yes	Yes
[8]	70-85	M (2) F (1)	Adenocarcinoma, tubulodesmoplastic type (2) Adenocarcinoma, tubulopapillary (1)	Unknown (3)	Probable (1) Possible (1) No (1)	Yes (2) Unknown (1)
[9]	70	M (1)	Laryngeal carcinoma metastatic to the pleura, poorly differentiated squamous cell	Shipyards electrician	Yes	Yes
[10]	Mean, 61	M (13) F (2)	Adenocarcinoma, mucin producing (15)	Not stated	Yes (3)	Yes (8)
[11]	Not stated	Not stated	Adenocarcinoma (23); Squamous carcinoma (2); Large cell undifferentiated carcinoma (1); Adenosquamous carcinoma (1)	Not stated	Not stated	Not stated
[12]	68 ±9 years	Not stated	Primary pulmonary adenocarcinoma (63); Primary squamous cell carcinomas of lung (2); Extrapulmonary tumors (7)–metastatic from kidney, ureter, urinary bladder, appendix vermiformis, thymoma, and cystosarcoma phyllodes of the contralateral mamma	Unknown (72)	Yes (2)	Average nonsmokers 44%
[13]	32	M (1)	Large cell carcinoma	Unknown	Unknown	Unknown
[14]	51-64	M (4)	Small cell carcinoma (4)	Foundry worker (1) Unknown (3)	Unknown (4)	Yes (4)
[15]	34-85	M (12) F (2)	Epithelioid angiosarcoma (7); Epithelioid hemangioendothelioma (7)	Unknown (14)	Yes (1) Unknown (13)	Unknown (14)
[16]	31-78; median age 63	M (24) F (5)	Adenocarcinoma (29)	Unknown (29)	Possible/definite (6)	Yes (13)
[17]	63-67	M (3)	Left pleural epithelioid neoplasm, papillary and alveolar cell morphology (1); Pleural tumor, probable undifferentiated adenocarcinoma (1); Pleural tumor that penetrated peritoneal cavity, biphasic with desmoplastic reaction with epithelioid cells producing mucus (1)	Unknown (3)	Yes (1) No (2)	Yes (2) Remote (1)
[18]	45-66	M (4) F (1)	Angiosarcoma, primary pleural (5)	Unknown (5)	Unknown (5)	Unknown (5)
[19]	33-73	M (3)	Epithelioid hemangioendothelioma, primary pleural (3)	Laborer (1) Shipyards joiner (1) Shipyards welder (1)	Yes (3)	Unknown (3)
[20]	75	M (1)	Adenocarcinoma, primary pulmonary	Biology teacher	Unknown	Unknown
[21]	73	M (2)	Atypical carcinoid tumor (2)	Power station worker (1) Shipyards worker (1)	Yes (1) Likely (1)	Yes (2)
[22]	14-20	M (2)	Primary pseudomesotheliomatous yolk-sac tumor (1); Embryonal carcinoma with yolk-sac tumor of the lung/mixed germ cell tumor (1)	Unknown (2)	Unknown (2)	Unknown (2)
[23]	74	M (1)	Pseudomesotheliomatous angiosarcoma	Unknown	No	No

Continuations of Table 1.

References	Age Range	Sex	Histologic Type	Occupation	Asbestos exposure?	Tobacco use?
[24]	33-77; median age 68 years	M (50) F (3)	Primary lung tumors=47 Adenocarcinoma (34) Pleomorphic carcinoma (5) Squamous carcinoma (4) Small cell carcinoma (2) Basaloid carcinoma (1) Carcinosarcoma (1) Metastatic carcinomas=6 Transitional cell (2) Pancreatic (1) Renal cell (1) Prostatic (1) Squamous carcinoma parotid (1)	Unknown	Yes – 40 (76%)	Yes – 46 (87%)
[25]	53	M (1)	Adenocarcinoma of lung	Unknown	Unknown	Unknown
[26]	35	M (1)	Primary signet ring cell carcinoma of lung	Construction laborer	Probable	Yes
[27]	58-73	M (4) F (3)	Adenocarcinoma, poorly differentiated (5); Large cell adenocarcinoma (1); Small cell carcinoma (1)	Unknown (7)	Unknown (7)	Unknown (7)
[28]	68	M (1)	Multiple myeloma	Unknown	Yes – environmental	Unknown
[29]	64	F (1)	Melanoma metastatic to pleura	Unknown	No	Yes
[30]	55	M (1)	Pleomorphic carcinoma with adenocarcinoma component	Unknown	No	Yes
[31]	45	M (1)	Erdheim-Chester disease	Construction worker	Probable	No
[32]	78	M (1)	Concomitant adenocarcinoma of lung, gastric cancer, and esophageal cancer	Unknown	No	Yes
[33]	53-66	M (3) F (1)	Adenocarcinoma of lung (4)	Unknown (4)	Yes (1) Unknown (3)	Yes (4)
[34]	72	M (1)	Adenocarcinoma of lung	Unknown	Unknown	Unknown
[35]	45-80	M (1) F (1)	Plasma cell myeloma/plasmacytoma (2)	Shipyard worker (1) Unknown (1)	Yes (1) with 122,000 asbestos bodies per gram dry lung tissue; Unknown (1)	Unknown (2)
[36]	37	M (1)	Angiosarcoma of the spleen with metastases to pleura and peritoneum	Unknown	No	Unknown
[37]	74	M (1)	Adenocarcinoma of lung, poorly-differentiated	Unknown	No known	Yes
[38]	65	M (1)	Merkel cell carcinoma	Underground coal miner in South Wales for 30 years	No	Not stated
[39]	76-80	M (2)	Adenocarcinoma, primary pulmonary (1); Squamous cell carcinoma of lung (1)	Unknown (2)	No known (2)	Yes (2)
[40]	53	M (1)	Pulmonary mucinous cystadenocarcinoma	Unknown	Yes	Yes

Key: M, male; F, female; Probable—cases in which there was no statement as to whether or not the patient was exposed to asbestos, however, based on their employment history, the likelihood exists.

were counted. The definition of such a ferruginous body included elongated/transparent central core and a rust colored beaded surface. The polycarbonate filters were prepared for ATEM analysis by a direct method involving collection of the digestate on the filter surface followed by carbon coating of the dried filter. The carbon coated filter was cut into strips and mounted on 100 mesh copper grids. A modified Jaffe-Wick method [44] was used to remove the filter matrix, leaving the carbon film containing the entrapped fibers, ferruginous bodies, and other particulates. Random areas on the grids

were evaluated at 16,000x for uncoated fibers in a JEOL 100CX transmission electron microscope which was interfaced with an EDAX DX Prime X-ray analyzer. An additional scan of other areas on the grids was conducted at 1,600x for the presence of additional ferruginous bodies. A fiber as defined in the present study consisted of an elongated entity $\geq 0.5\mu\text{m}$ with parallel sides for a majority of its length and an aspect ratio of greater than 5:1. Uncoated fibers as well as the core material of ferruginous bodies were analyzed as to elemental composition by X-ray energy dispersive spectrometry

(XEDS) and for crystalline structure by selected area electron diffraction (SAED)".

Results

Approximately 90% of the cases received for evaluation by one of us (SPH) were thought clinically to have diffuse malignant pleural mesothelioma and two were thought to be peritoneal mesotheliomas. The most common clinical symptom was dyspnea on exertion. Other common symptoms included chest pain/discomfort, cough, weight loss, and fatigue. Less frequent symptoms included abdominal pain/distention, back pain, shoulder pain, fever, weakness, and anorexia. Many patients exhibited more than one symptom. The most frequent radiographic changes included pleural thickening/nodularity and a unilateral pleural effusion that often re-accumulated rapidly. Following pathologic evaluation by one of us (SPH), one-hundred eighty three (183) of the 196 cases were determined to be primary in the lung; 2 were primary in the peritoneum; and 11 were metastatic to the lung from another site (kidney-4; skin-3; mouth/tongue-2; Mullerian origin-1; and possibly larynx-1). Of the 196 cases, 173 were males, 21 were females, and in 2 cases the sex was unknown. The age-range was between 23 and 96 years with a mean age of 62.89 years.

A summary of the 196 cases evaluated in our laboratory (Diagnostic Specialties Laboratory, Inc. P.S.) is shown in [Table 2](#). The various histologic types identified in our cases are shown in [Table 3](#). The macroscopic and ultrastructural features of a pseudomesotheliomatous pulmonary adenocarcinoma are shown in [Figures 1-5](#).

One hundred thirty-four patients (68.3%) had a known history of exposure to asbestos (130 occupational and 4 bystander/paraoccupational); six (6) had no history of exposure to asbestos; and in 56 cases, the exposure history was unknown. It should be stated that in 6 cases where the occupational history was known (painter; welder in a steel mill; digester/cooker in a pulp/paper mill; shipyard worker-2 cases; and crew boat captain/welder/fisherman) but the asbestos exposure history was stated to be "unknown," one has to wonder if there was possible exposure to asbestos based on their occupation/job title. Of the 62 cases where there was no known history or an unknown history of asbestos exposure, 25 (40.3%) had either pathologic or radiographic markers of asbestos exposure, e.g., pleural plaques, asbestosis, and/or ferruginous bodies/asbestos fibers in lung tissue. Pleural plaque characteristic of plaque caused by asbestos was identified in 89 cases (56 pathologically, 12 radiographically, and 21 both pathologically and radiographically). Forty-six (46) cases had pathologically definable asbestosis (CAP-NIOSH 1982). Radiographic asbestosis was identified in 4 cases and 1 had probable asbestosis.

A total of 59 cases were evaluated in the laboratory of one of us (Samuel P. Hammar, M.D.) for ferruginous bodies that were morphologically characteristic of asbestos bodies (5 by iron stained sections and 54 using quantitative asbestos digestion

Figure 1. This tumor has the macroscopic features of a pleural mesothelioma, being encased by a rind of tumor that when examined microscopically had features of a primary pulmonary adenocarcinoma.

Figure 2. Cross-section of pseudomesotheliomatous pulmonary adenocarcinoma.

Figure 3. This pseudomesotheliomatous adenocarcinoma surrounds the heart and lung.

Figure 4. Ultrastructural evaluation of this pseudomesotheliomatous adenocarcinoma of lung shows short microvilli and a fuzzy glycocalyx; whereas, in a pleural epithelioid mesothelioma, the microvilli would be long and sinuous and not covered by glycocalyx (see [Figure 5](#)).

Figure 5. Ultrastructural evaluation of a pleural epithelioid mesothelioma showing long, sinuous microvilli that are not covered by glycocalyx.

analysis). In addition, asbestos fiber analysis was performed in Dr. Ronald F. Dodson's laboratory on 24 cases. These cases were evaluated using standardized techniques as described in the Materials and Methods section. Results are shown in [Table 4](#). By quantitative asbestos digestion analysis, 47 of 54 cases had above background levels (over 20 ferruginous bodies per gram wet lung tissue) in at least one or more lobes of lung. It should be noted that in 4 cases where the results fell below background levels (20 or less ferruginous bodies per gram wet lung tissue in our laboratory), when fiber analysis was performed, those same four cases showed background levels at the upper limits of levels found in general populations (see cases #160, 163, 164, and 165) and often the burden in one lung would greatly exceed the average found in the general studies conducted by one of us (RFD). This illustrates that asbestos fibers are not evenly distributed in the lungs. Of the 20 cases studied by analytical transmission electron microscopy (ATEM) in the laboratory of Ronald F. Dodson, Ph.D., for ferruginous bodies and uncoated fibers [[43](#)], 19 cases contained tissue burden of asbestos in at least one of the lung samples in appreciable excess of the average background levels found in the general population studies [[41,45](#)]. The numbers of asbestos bodies identified in the right lung versus the left lung also varied, which further illustrates that asbestos fibers are not evenly distributed in the lungs. Of the 196 cases, 109 (55.6%) were cigarette smokers, 23 (11.7%) were nonsmokers, and in 64 cases the smoking history was unknown. Of the 109 patients who were known smokers, 61 had a greater than 20-pack year history of cigarette smoking.

Table 2. Case summary of 196 cases of pseudomesotheliomatous neoplasms.

ID#	Age	Sex	Smoking History	Occupational History	Asbestos exposure?	Pleural plaques	Asbestosis (1982 CAP-NIOSH)	Ferruginous bodies OR Asbestos fibers (Refer to Table 4)	Pathologic diagnosis	Survival
110	63	M	40-pack years	Automotive mechanic	Yes	No	No	No FB detected	Adenocarcinoma of lung, acinar and signet ring morphology	17 months
001	59	M	Unknown	Shipyards worker	Unknown	P	No	--	Adenocarcinoma of lung, acinar type	Unknown
150/FA05	76	M	1 pack per day, # of years unknown	Built kitchen equipment	Yes	P	P Grade 3-4	FB and AF above background	Adenocarcinoma of lung, acinar type	1 month
159/FA14	59	M	27 to 80-pack years	Shipyards sandblaster & painter (13 years); head hooker and furnace manager at a steel plant (18 years); laborer	Yes	P	R	FB and AF above background	Adenocarcinoma of lung, acinar type	6 months
003	67	M	Yes-amount not specified	Millwright	Yes	No	No	FB above background	Adenocarcinoma of lung, anaplastic large cell undifferentiated	6 months
166/U01	96	M	Unknown	Boilermaker in shipyards during 1940s	Yes	P	P Grade 4	FB above background	Adenocarcinoma of lung, biphasic type	3 months
146/FA01	70	M	30-pack years	Insulator helper (5 years)	Yes	P	P Grade 4	FB and AF above background	Adenocarcinoma of lung, biphasic type	8 months
151/FA06	43	M	5+pack years	Batchmaker/mixer, hod carrier, pipelayer, laborer, maintenance man	Yes	No	No	FB and AF above background	Adenocarcinoma of lung, epithelioid and rhabdoid type; metastases to liver and lymph nodes	<1 year
112	83	F	3 to 6-pack years	Husband worked as a contractor and laborer at shipyards and refineries	Para-occupational	No	No	--	Adenocarcinoma of lung, glandular differentiation	8 months
082	79	M	Unknown	Unknown	Unknown	No	No	--	Adenocarcinoma of lung, glandular differentiation	Unknown
076	65	U	Unknown	Unknown	Unknown	No	No	--	Adenocarcinoma of lung, glandular differentiation	Unknown
048	70	M	No	Sheet metal worker	Yes	P	No	--	Adenocarcinoma of lung, glandular differentiation	6 months
068	73	M	25 to 35-pack years	Carpenter (industrial)	Yes	P, R	P Grade 4	Iron stains: 01 ferruginous body characteristic of an asbestos body	Adenocarcinoma of lung, glandular differentiation	12 months
051	69	M	No	Laborer, welder, coal miner, automobile mechanic	Yes	No	No		Adenocarcinoma of lung, glandular differentiation; metastasis to abdominal cavity	4 months

Continuation of Table 2.

ID#	Age	Sex	Smoking History	Occupational History	Asbestos exposure?	Pleural plaques	Asbestosis (1982 CAP-NIOSH)	Ferruginous bodies OR Asbestos fibers (Refer to Table 4)	Pathologic diagnosis	Survival
002	U	M	Unknown	Unknown	Unknown	No	No	FB above background	Adenocarcinoma of lung, glandular/papillary type	Unknown
004	46	M	Yes - amount not specified	Foundry worker, engineer	Yes	No	No	--	Adenocarcinoma of lung, glandular/tubular differentiation	Unknown
077	72	M	30 to 49-pack years	Service station attendant; machinist's mate in U.S. Navy; friction and gasket exposure	Yes	P	P Grade 1	Iron stains: 44 ferruginous bodies characteristic of asbestos bodies in 10.9 square cm or 4 asbestos bodies per square cm	Adenocarcinoma of lung, glandular/tubular differentiation	20 months
006	44	F	Unknown	Unknown	Unknown	No	P Grade 2		Adenocarcinoma of lung, moderately differentiated	Unknown
155/FA10	62	M	10-pack years	Electrician (45 years)	Yes	P, R	No	FB and AF above background	Adenocarcinoma of lung, moderately differentiated; metastases to liver, gallbladder, and thyroid	3 months
056	65	M	50-pack years max	Floor coverer	Yes	P	P Grade 2-3	FB above background	Adenocarcinoma of lung, moderately to poorly differentiated	11 months
148/FA03	75	M	45 to 60-pack years	Shipfitter, chipper, caulker, nuclear test director at shipyard	Yes	P, R	P Grade 3-4	FB and AF above background	Adenocarcinoma of lung, moderately to poorly differentiated; metastases to adrenals	2 months
010	74	M	Yes - amount not specified	Unknown	No	No	No	--	Adenocarcinoma of lung, mucin producing	Unknown
030	54	U	Unknown	Unknown	Unknown	No	No	--	Adenocarcinoma of lung, mucin producing	Unknown
017	63	M	Unknown	Unknown	Unknown	No	No	--	Adenocarcinoma of lung, mucin producing	Unknown
028	U	M	Unknown	Unknown	Unknown	No	No	--	Adenocarcinoma of lung, mucin producing	2 months
012	76	M	Unknown	Unknown	Unknown	No	No	--	Adenocarcinoma of lung, mucin producing	Unknown
007	81	F	Yes - amount not specified	Unknown	Unknown	No	No	--	Adenocarcinoma of lung, mucin producing	Unknown
022	87	F	Unknown	Unknown	Unknown	No	No	--	Adenocarcinoma of lung, mucin producing	Unknown

Continuation of Table 2.

ID#	Age	Sex	Smoking History	Occupational History	Asbestos exposure?	Pleural plaques	Asbestosis (1982 CAP-NIOSH)	Ferruginous bodies OR Asbestos fibers (Refer to Table 4)	Pathologic diagnosis	Survival
029	72	F	Yes - amount not specified	Clerk	Unknown	No	No	--	Adenocarcinoma of lung, mucin producing	3 weeks
033	69	M	70 to 105-pack years	Unknown	Unknown	P, R	No	--	Adenocarcinoma of lung, mucin producing	17 months
032	85	M	Unknown	Unknown	Unknown	No	No	Iron stains: 03 ferruginous bodies characteristic of asbestos bodies	Adenocarcinoma of lung, mucin producing	Unknown
027	83	M	40 to 140-pack years	Rigger, shipfitter in U.S. Navy	Yes	No	No	--	Adenocarcinoma of lung, mucin producing	11 months
011	68	M	Unknown	Electrician	Yes	No	No	--	Adenocarcinoma of lung, mucin producing	Unknown
031	59	M	Unknown	Unknown	Yes	P	No	--	Adenocarcinoma of lung, mucin producing	Unknown
009	65	M	92-pack years	Welder, maintenance man	Yes	P	No	--	Adenocarcinoma of lung, mucin producing	5 months
014	75	M	20-pack years	Shipfitter, merchant marine, plasterer	Yes	P	No	--	Adenocarcinoma of lung, mucin producing	Unknown
023	77	M	15-pack years	Refinery worker	Yes	P, R	No	--	Adenocarcinoma of lung, mucin producing	Unknown
018	73	M	20 to 120-pack years	Electrician, welder	Yes	No	P Grade 2	--	Adenocarcinoma of lung, mucin producing	2 months
016	56	M	Unknown	Maintenance engineer (30 years)	Yes	No	P Grade 2	--	Adenocarcinoma of lung, mucin producing	20 months
026	66	M	20-pack years	Construction worker, pipefitter, hod carrier	Yes	No	No	FB above background	Adenocarcinoma of lung, mucin producing	2 days
041	42	M	5 to 10-pack years	Pipefitter, HVAC technician	Yes	No	No	FB above background	Adenocarcinoma of lung, mucin producing	6 months
015	71	M	60-pack years	Iron worker	Yes	P, R	No	FB above background	Adenocarcinoma of lung, mucin producing	1 month
034	57	M	Unknown	Unknown	Yes	No	P Grade 1	FB above background	Adenocarcinoma of lung, mucin producing	Unknown
008	55	M	No	Lived in close proximity to cement plants; worked for father's pipeline business; automotive maintenance	Yes	P	P Grade 3	FB above background	Adenocarcinoma of lung, mucin producing	11 days
013	50	M	25-pack years	Boilermaker	Yes	P	P Grade 2	Iron stains: 46 ferruginous bodies characteristic of asbestos bodies in lung tissue and 6 FB in hilar lymph nodes	Adenocarcinoma of lung, mucin producing	3 months

Continuation of Table 2.

ID#	Age	Sex	Smoking History	Occupational History	Asbestos exposure?	Pleural plaques	Asbestosis (1982 CAP-NIOSH)	Ferruginous bodies OR Asbestos fibers (Refer to Table 4)	Pathologic diagnosis	Survival
035	65	M	2 packs per day; # of years unknown	Unknown	Yes	No	No	--	Adenocarcinoma of lung, mucin producing with deciduoid morphology	2 months
020	62	M	7-pack years	Plumber, electrician	Yes	P, R	No	--	Adenocarcinoma of lung, mucin producing with deciduoid morphology	11 months
036	59	M	80-pack years	Worked at a pipe company (job title unknown)	Yes	P	No	Iron stains: Rare ferruginous bodies characteristic of asbestos bodies	Adenocarcinoma of lung, mucin producing, acinar type	Unknown
037	67	F	Unknown	Unknown	Unknown	No	No	--	Adenocarcinoma of lung, mucin producing, glandular differentiation	Unknown
024	65	M	Yes - 40 years (rate unknown)	Electrician, aircraft mechanic	Yes	No	No	--	Adenocarcinoma of lung, mucin producing, tubular/glandular	22 months
021	63	M	Unknown	Unknown	Unknown	P	No	--	Adenocarcinoma of lung, mucin producing, tubulodesmoplastic type	Unknown
075	70	M	20-pack years	Worked with insulated copper tubing	Yes	No	No	--	Adenocarcinoma of lung, mucin-producing	1 month
044	75	M	No	Painter, laborer, sandblaster	Yes	No	P Grade 4	--	Adenocarcinoma of lung, mucin-producing	12 months
169/U04	63	F	20-pack years	Paraoccupational and bystander exposure to asbestos	Yes	No	No	--	Adenocarcinoma of lung, mucin-producing, probable Mullerian origin based on nuclear staining for estrogen receptor protein	15 months
039	73	M	Unknown	Unknown	Unknown	No	No	--	Adenocarcinoma of lung, not otherwise specified	Unknown
079	75	F	40+ pack years	Unknown	Unknown	No	No	--	Adenocarcinoma of lung, not otherwise specified	Unknown
085	75	F	Yes - amount not specified	Unknown	Unknown	No	No	--	Adenocarcinoma of lung, not otherwise specified	Unknown
161/FA16	U	M	Unknown	Unknown	Unknown	No	No	AF above background	Adenocarcinoma of lung, not otherwise specified	Unknown

Continuation of Table 2.

ID#	Age	Sex	Smoking History	Occupational History	Asbestos exposure?	Pleural plaques	Asbestosis (1982 CAP-NIOSH)	Ferruginous bodies OR Asbestos fibers (Refer to Table 4)	Pathologic diagnosis	Survival
088	58	M	Yes - amount not specified	Unknown	Unknown	No	No	FB above background; 2 AB in iron stained sections	Adenocarcinoma of lung, not otherwise specified	Unknown
164/FA19	64	M	1 pack per day; # of years unknown	Unknown	Unknown	No	No	FB below background; AF above background	Adenocarcinoma of lung, not otherwise specified	Unknown
047	68	M	Unknown	Carpenter, laborer	Yes	No	No	--	Adenocarcinoma of lung, not otherwise specified	3 days
074	82	M	Unknown	Unknown	Yes	No	No	--	Adenocarcinoma of lung, not otherwise specified	Unknown
052	70	M	140 to 160-pack years	Pipefitter, steamfitter, plumber, logger	Yes	No	No	--	Adenocarcinoma of lung, not otherwise specified	3 months
045	67	M	100-pack years	Engineer and sailor on barges	Yes	No	No	--	Adenocarcinoma of lung, not otherwise specified	5 months
055	54	M	36-pack years	Rigger, bricklayer's helper, boilermaker	Yes	No	No	--	Adenocarcinoma of lung, not otherwise specified	Unknown
059	51	M	20-pack years	Electrician	Yes	No	No	--	Adenocarcinoma of lung, not otherwise specified	2 months
054	64	M	1/2 to 2 packs per day until 1970	Welder, pipefitter	Yes	No	No	--	Adenocarcinoma of lung, not otherwise specified	3 months
072	78	M	5-pack years	Longshoreman	Yes	No	No	--	Adenocarcinoma of lung, not otherwise specified	< 1 year
046	68	M	12-pack years	Sheet metal worker in U.S. Navy	Yes	No	No	--	Adenocarcinoma of lung, not otherwise specified	3 months
062	68	M	48 to 96-pack years	Automotive mechanic, carpenter	Yes	P	No	--	Adenocarcinoma of lung, not otherwise specified	Unknown
053	68	M	25-pack years	Electrical company employee (job title not specified)	Yes	P	No	--	Adenocarcinoma of lung, not otherwise specified	Unknown
078	79	M	30 to 60-pack years	Plumber	Yes	P	No	--	Adenocarcinoma of lung, not otherwise specified	2 months
058	64	M	21-pack years	Plumber	Yes	P, R	No	--	Adenocarcinoma of lung, not otherwise specified	Unknown

Continuation of Table 2.

ID#	Age	Sex	Smoking History	Occupational History	Asbestos exposure?	Pleural plaques	Asbestosis (1982 CAP-NIOSH)	Ferruginous bodies OR Asbestos fibers (Refer to Table 4)	Pathologic diagnosis	Survival
057	71	M	30-pack years	Welder, pipefitter	Yes	R	No	--	Adenocarcinoma of lung, not otherwise specified	24 months
071	65	M	30-pack years	Sheet metal worker	Yes	R	No	--	Adenocarcinoma of lung, not otherwise specified	2 months
086	68	M	52 to 66-pack years	Boiler tender	Yes	R	No	--	Adenocarcinoma of lung, not otherwise specified	9 months
070	65	M	Unknown	U.S. Navy	Yes	R	No	--	Adenocarcinoma of lung, not otherwise specified	Unknown
060	70	M	45 to 72-pack years	Bricklayer, laborer, crane operator, machinist, rotoblast operator	Yes	R	No	--	Adenocarcinoma of lung, not otherwise specified	22 months
064	83	M	50-pack years	Unknown	Yes	R	No	--	Adenocarcinoma of lung, not otherwise specified	Unknown
049	59	M	29 to 80-pack years	Pipefitter, steamfitter	Yes	No	P Grade 3	--	Adenocarcinoma of lung, not otherwise specified	4 days
084	64	M	Yes - amount not specified	Pipefitter	Yes	P	P Grade 1-2	--	Adenocarcinoma of lung, not otherwise specified	2 months
042	61	M	82-pack years	Plasterer, carpenter	Yes	P, R	P Grade 1-2	--	Adenocarcinoma of lung, not otherwise specified	11 months
061	65	M	Unknown	Laborer, heavy equipment operator at an aluminum plant	Yes	R	P Grade 2	--	Adenocarcinoma of lung, not otherwise specified	2 months
073	71	M	27-pack years	Longshoreman	Yes	P	R	--	Adenocarcinoma of lung, not otherwise specified	8 months
066	77	M	No	Plasterer	Yes	No	No	FB above background	Adenocarcinoma of lung, not otherwise specified	6 months
050	58	M	40-pack years	Sheet metal worker	Yes	No	No	FB above background	Adenocarcinoma of lung, not otherwise specified	15 months
067	80	M	Unknown	Asbestos worker	Yes	P	No	FB above background	Adenocarcinoma of lung, not otherwise specified	Unknown
081	65	M	Yes - amount not specified	Asbestos brake plant worker	Yes	P	No	FB above background	Adenocarcinoma of lung, not otherwise specified	Unknown

Continuation of Table 2.

ID#	Age	Sex	Smoking History	Occupational History	Asbestos exposure?	Pleural plaques	Asbestosis (1982 CAP-NIOSH)	Ferruginous bodies OR Asbestos fibers (Refer to Table 4)	Pathologic diagnosis	Survival
063	76	M	2-pack years	Pipefitter in U.S. Army	Yes	P, R	P Grade 2-3	FB above background	Adenocarcinoma of lung, not otherwise specified	Unknown
152/ FA07	69	M	55 to 100-pack years	Steamfitter and plumber (25 years)	Yes	P	P Grade 3-4	FB and AF above background	Adenocarcinoma of lung, not otherwise specified	20 months
149/ FA04	75	M	100-pack years	Shipyard electrician (35 years)	Yes	P	P Grade 3-4	FB and AF above background	Adenocarcinoma of lung, not otherwise specified	7 months
065	75	M	No	Laborer, mechanic, heavy equipment operator, lathe operator	Yes	P	No	Iron stains: 01 ferruginous body characteristic of an asbestos body	Adenocarcinoma of lung, not otherwise specified	Unknown
083	52	M	No	Carpenter	Yes	No	No	Iron stains: 02 ferruginous bodies characteristic of asbestos bodies	Adenocarcinoma of lung, not otherwise specified	5 months
087	84	M	35-pack years	U.S. Navy Seaman 1st Class and Gunner's Mate; Marine electrician and mechanic in shipyards; drywall work	Yes	P, R	P Grade 2-3	Iron stains: 03 ferruginous bodies characteristic of asbestos bodies	Adenocarcinoma of lung, not otherwise specified	6 months
069	71	M	7-pack years	Boiler tender/fireman in US Navy	Yes	P, R	P Grade 4	Iron stains: 06 ferruginous bodies characteristic of asbestos bodies	Adenocarcinoma of lung, not otherwise specified	1 month
043	71	M	Minimal	Machinist Mate, pipefitter, brake work, drywall work	Yes	P, R	P Grade 2	Iron stains: 12 ferruginous bodies characteristic of asbestos bodies	Adenocarcinoma of lung, not otherwise specified	7 months
163/ FA18	62	M	Unknown	Unknown	Unknown	No	No	FB below background; AF above background	Adenocarcinoma of lung, not otherwise specified; metastases to liver and kidney	6 months
157/ FA12	64	M	Unknown	Shipyard insulator & shipwright (5 years); lineman	Yes	P	P Grade 2-3	FB and AF above background	Adenocarcinoma of lung, not otherwise specified; metastases to mesentery, omentum, and other peritoneal surfaces	8 months
154/ FA09	71	M	39-pack years	Wiper & oiler (3 years); insulator & pipefitter (35 years)	Yes	P	P Grade 1	FB and AF above background	Adenocarcinoma of lung, papillary (type II pneumocyte origin by EM); metastases to left lung, omentum, and lymph nodes	14 months

Continuation of Table 2.

ID#	Age	Sex	Smoking History	Occupational History	Asbestos exposure?	Pleural plaques	Asbestosis (1982 CAP-NIOSH)	Ferruginous bodies OR Asbestos fibers (Refer to Table 4)	Pathologic diagnosis	Survival
090	57	F	42 to 50-pack years	Domestic exposure from father (shipyard mechanic), husband (assembler at aircraft manufacturing plant), and ex-husband (contractor)	Para-occupational	R	No	--	Adenocarcinoma of lung, papillary type	Unknown
005	64	F	Unknown	Unknown	Unknown	No	No	--	Adenocarcinoma of lung, papillary type	Unknown
089	52	M	No	Smelter and refinery worker	Yes	No	No	FB above background	Adenocarcinoma of lung, papillary type	10 months
165/FA20	53	M	20 to 21-pack years	Laborer, carpenter, service station manager	Yes	No	No	FB below background; AF above background	Adenocarcinoma of lung, pleomorphic type, poorly differentiated	Unknown
103	66	F	Yes - amount not specified	Analyst (management) in shipyard	Bystander	No	No	--	Adenocarcinoma of lung, poorly differentiated	29 months
104	77	M	Unknown	Unknown	Unknown	No	No	--	Adenocarcinoma of lung, poorly differentiated	Unknown
099	85	M	Yes - amount not specified	Engineer for government	Unknown	No	No	FB above background	Adenocarcinoma of lung, poorly differentiated	15 months
096	63	M	Unknown	Unknown	Unknown	P	P Grade 3	FB above background	Adenocarcinoma of lung, poorly differentiated	Unknown
097	64	M	1 pack per day; # of years unknown	Unknown	Unknown	No	No	FB below background	Adenocarcinoma of lung, poorly differentiated	Unknown
106	66	M	20-pack years	Coal miner/dragline operator stripping coal	Yes	No	No	--	Adenocarcinoma of lung, poorly differentiated	14 months
135	63	M	41-pack years	Engineer	Yes	No	No	--	Adenocarcinoma of lung, poorly differentiated	Unknown
101	70	M	No	Tank mechanic in U.S. Army (exposed to friction products); Ranch operator - performed repairs on farm equipment-friction	Yes	No	No	--	Adenocarcinoma of lung, poorly differentiated	6 weeks
094	77	M	Yes - amount not specified	Longshoreman	Yes	No	No	--	Adenocarcinoma of lung, poorly differentiated	Unknown
102	49	M	28 years (rate unknown)	Insulator	Yes	No	No	--	Adenocarcinoma of lung, poorly differentiated	Unknown

Continuation of Table 2.

ID#	Age	Sex	Smoking History	Occupational History	Asbestos exposure?	Pleural plaques	Asbestosis (1982 CAP-NIOSH)	Ferruginous bodies OR Asbestos fibers (Refer to Table 4)	Pathologic diagnosis	Survival
095	69	M	Unknown	Shipyard worker	Yes	No	No	FB above background	Adenocarcinoma of lung, poorly differentiated	Unknown
093	40	M	No	Mechanic, machinist	Yes	No	No	FB above background	Adenocarcinoma of lung, poorly differentiated	Unknown
092	48	M	52-pack years	U.S. Army; bystander during remodeling/ construction of drug store	Yes	No	No	FB above background	Adenocarcinoma of lung, poorly differentiated	11 months
091	55	M	76-pack years	Heavy truck and equipment mechanic	Yes	No	P Grade 2	FB above background	Adenocarcinoma of lung, poorly differentiated	5 months
098	60	M	22 to 33-pack years	Electrician, brick-layer	Yes	P, R	P Grade 2	FB above background	Adenocarcinoma of lung, poorly differentiated	Unknown
100	68	M	No	Machinist, boatswains mate, marine mechanic; home remodeling; automotive repair	Yes	P	No	Iron stains: 01 ferruginous body characteristic of an asbestos body	Adenocarcinoma of lung, poorly differentiated	6 months
105	67	F	23-pack years	Laborer at a brake factory assembling brake pads	Yes	P	P Grade 3	Iron stains: 05 ferruginous bodies characteristic of asbestos bodies	Adenocarcinoma of lung, poorly differentiated	3 months
158/FA13	U	M	Unknown	Unknown	Unknown	P	P Grade 2	FB and AF above background	Adenocarcinoma of lung, poorly differentiated; metastases to lymph nodes and thyroid	Unknown
107	60	F	Unknown	Unknown	No	No	P Grade 2	--	Adenocarcinoma of lung, possible type II pneumocyte origin	Unknown
167/U02	23	F	Unknown	Unknown	Unknown	No	No	--	Adenocarcinoma of lung, presumably of pulmonary origin	Unknown
108	63	F	Unknown	Unknown	No	No	No	--	Adenocarcinoma of lung, probable Clara cell origin	Unknown
109	83	M	Unknown	Unknown	Unknown	P	No	--	Adenocarcinoma of lung, signet ring morphology	Unknown
170/U05	55	M	5-pack years	Boilerman, pipefitter, machinist	Yes	P, R	No	--	Adenocarcinoma of lung, signet ring morphology	5 months
038	60	M	No	Electrician	Yes	No	R	--	Adenocarcinoma of lung, signet ring, mucin producing	2 months
080	71	M	No	Electrician	Yes	P	No	--	Adenocarcinoma of lung, tubular and glandular differentiation	8 months

Continuation of Table 2.

ID#	Age	Sex	Smoking History	Occupational History	Asbestos exposure?	Pleural plaques	Asbestosis (1982 CAP-NIOSH)	Ferruginous bodies OR Asbestos fibers (Refer to Table 4)	Pathologic diagnosis	Survival
040	74	M	Unknown	Unknown	Yes	P	P Grade 1-2	--	Adenocarcinoma of lung, tubular and glandular differentiation	Unknown
140	78	M	5-pack year maximum	Insulator	Yes	No	P Grade 3-4	Iron stains: Numerous ferruginous bodies characteristic of asbestos bodies	Adenocarcinoma of lung, tubular and glandular differentiation	1 month
116	67	M	1.5-2 packs/day; # of years unknown	Digester cooker in a pulp/paper mill	Unknown	No	No	--	Adenocarcinoma of lung, tubulodesmoplastic type	Unknown
119	79	M	Yes - amount not specified	Rancher	Unknown	No	No	--	Adenocarcinoma of lung, tubulodesmoplastic type	Unknown
122	42	M	Unknown	Unknown	Unknown	No	No	--	Adenocarcinoma of lung, tubulodesmoplastic type	Unknown
121	64	M	Unknown	Unknown	Unknown	No	No	--	Adenocarcinoma of lung, tubulodesmoplastic type	Unknown
113	58	M	No	Welder at steel mill	Unknown	P	No	--	Adenocarcinoma of lung, tubulodesmoplastic type	6 months
114	54	M	Unknown	Unknown	Unknown	No	No	FB above background	Adenocarcinoma of lung, tubulodesmoplastic type	Unknown
120	74	M	Unknown	Unknown	Unknown	P	P Grade 2-3	Iron stains: 11 ferruginous bodies characteristic of asbestos bodies	Adenocarcinoma of lung, tubulodesmoplastic type	Unknown
117	65	M	22.5-pack years	Foundry worker	Yes	No	No	--	Adenocarcinoma of lung, tubulodesmoplastic type	Unknown
115	41	M	33-pack years	Machinist, brake and clutch work on personal vehicles	Yes	No	No	--	Adenocarcinoma of lung, tubulodesmoplastic type	Unknown
111	69	M	75-pack years	Boilermaker, welder	Yes	No	No	--	Adenocarcinoma of lung, tubulodesmoplastic type	5 months
123	66	M	No	Marine machinist, railroad brakeman	Yes	P	No	AF above background	Adenocarcinoma of lung, tubulodesmoplastic type	6 months
118	73	M	Yes - amount not specified	Shipyards worker and in U.S. Navy - exposed to gaskets, packing, refractories, boilers, pumps, etc.	Yes	No	No	FB above background; 3 AB in iron stained sections	Adenocarcinoma of lung, tubulodesmoplastic type	Unknown

Continuation of Table 2.

ID#	Age	Sex	Smoking History	Occupational History	Asbestos exposure?	Pleural plaques	Asbestosis (1982 CAP-NIOSH)	Ferruginous bodies OR Asbestos fibers (Refer to Table 4)	Pathologic diagnosis	Survival
153/FA08	61	M	20 to 54-pack years	Electrician in U.S. Navy (20 years)	Yes	No	No	FB and AF above background	Adenocarcinoma of lung, tubulodesmoplastic type; metastases to liver, adrenal, and lymph nodes	6 months
156/FA11	U	M	Unknown	Unknown	Unknown	No	No	FB and AF above background	Adenocarcinoma of lung, tubulodesmoplastic type; metastasis to liver	Unknown
126	72	M	No	Coppersmith, oiler, wiper, fireman, water tender	Yes	No	No	--	Adenocarcinoma of lung, tubulopapillary type	Unknown
124	76	M	No (smoked a pipe)	Refinery worker/laborer; paraoccupational exposure from father who was a boilermaker	Yes	P	No	--	Adenocarcinoma of lung, tubulopapillary type	7 months
125	63	M	40 to 61-pack years	Electrician	Yes	No	R	--	Adenocarcinoma of lung, tubulopapillary/ glandular type	11 months
131	78	M	Unknown	Unknown	Unknown	No	No	--	Adenosquamous carcinoma of lung	Unknown
129	74	M	15-pack years	Unknown	Unknown	No	P Grade 1-2	--	Adenosquamous carcinoma of lung	9 months
128	62	M	Unknown	Unknown	Unknown	P	No	FB above background	Adenosquamous carcinoma of lung	Unknown
127	80	M	Unknown	Unknown	Unknown	P	P Grade 1-2	FB above background	Adenosquamous carcinoma of lung	Unknown
147/FA02	74	M	40-pack years	Shipyards worker (29 years)	Yes	P, R	P Grade 3-4	FB and AF above background	Adenosquamous carcinoma of lung	19 months
145	70	M	102-pack years	Shipfitter, steamfitter	Yes	P, R	P Grade 2	Iron stains: 43 ferruginous bodies characteristic of asbestos bodies	Adenosquamous carcinoma of lung	7 months
130	58	M	Unknown	Laborer, pipefitter, welder, plumber	Yes	P	P Grade 4	Iron stains: Several ferruginous bodies characteristic of asbestos bodies	Adenosquamous carcinoma of lung	Unknown
160/FA15	67	M	Unknown	Shipyards worker (3 years); boat-swains mate (9 years)	Unknown	P	No	FB below background; AF above background	Adenosquamous carcinoma of lung, poorly differentiated; metastasis to liver	2 months
132	60	M	Unknown	Mechanic/maintenance man	Yes	No	No	FB above background	Adenosquamous carcinoma of lung, poorly differentiated	4 months
171/U06	59	M	60-pack years	Inspector for gas company	Yes	P	No	--	Basaloid carcinoma	<3 months

Continuation of Table 2.

ID#	Age	Sex	Smoking History	Occupational History	Asbestos exposure?	Pleural plaques	Asbestosis (1982 CAP-NIOSH)	Ferruginous bodies OR Asbestos fibers (Refer to Table 4)	Pathologic diagnosis	Survival
134	74	M	Yes - amount not specified	Unknown	Yes	P	P Grade 3	FB above background	Bronchioloalveolar cell carcinoma	Unknown
133	61	M	44-pack years	Boilerman	Yes	P	P Grade 4	FB below background	Bronchioloalveolar cell carcinoma	Unknown
172/U07	43	M	Unknown	Unknown	Unknown	No	No	--	Calcifying fibrous tumor of the pleura	Unknown
175/U10	67	M	Yes - amount not specified	Worked with industrial solvents and chemicals used for tanning hides	No	No	No	--	Sarcomatoid carcinoma	Unknown
174/U09	81	M	Unknown	Unknown	Unknown	P	No	--	Sarcomatoid carcinoma	Unknown
173/U08	68	M	Yes - amount not specified	Driller in shipyard	Yes	P	No	FB above background	Sarcomatoid carcinoma	11 months
137	69	M	No	Carpenter/Joiner at boatbuilding company	Yes	P	No	FB above background	Sarcomatoid carcinoma	4 months
136	76	M	120-pack years	Insulator	Yes	P, R	P Grade 4	FB above background	Sarcomatoid carcinoma	Unknown
176/U11	80	M	12-pack years	Steamfitter, pipefitter	Yes	P, R	P Grade 2	Iron stains: 182 ferruginous bodies characteristic of asbestos bodies in 5.7 sq. cm. or 31.9 AB per sq. cm. of lung tissue	Sarcomatoid carcinoma	4 months
186/U21	60	M	11.5-pack years	Electrician, electrical engineer, production engineer, general manager	Yes	R	No	Iron stains: No ferruginous bodies	Combined pseudo-mesotheliomatous adenocarcinoma of lung; and a poorly differentiated basaloid squamous cell carcinoma arising from the sino-nasal region that was metastatic to the liver and skull	6 years
189/U24	67	M	Unknown	Sheet metal worker	Yes	P	No	FB above background	Combined pseudo-mesotheliomatous mucin-producing adenocarcinoma of the lung and a biphasic mesothelioma	3 months
178/U13	59	M	Unknown	Crew boat captain, welder, commercial fisherman	Unknown	No	No	Iron stains: No ferruginous bodies	Combined pseudo-mesotheliomatous small cell adenocarcinoma or small cell squamous cell carcinoma & pleural mesothelioma	Unknown

Continuation of Table 2.

ID#	Age	Sex	Smoking History	Occupational History	Asbestos exposure?	Pleural plaques	Asbestosis (1982 CAP-NIOSH)	Ferruginous bodies OR Asbestos fibers (Refer to Table 4)	Pathologic diagnosis	Survival
177/ U12	67	M	20.5 to 41-pack years	Automotive mechanic, laborer, welder, carpenter	Yes	R	R (probable)	Iron stains: 01 ferruginous body characteristic of an asbestos body	Combined pseudo-mesotheliomatous small cell lung cancer and poorly differentiated adenocarcinoma	10 months
181/ U16	38	F	Unknown	Unknown	No	No	No	--	Hemangio-endothelioma, left pleural	Unknown
180/ U15	59	F	No	Lab Technician in healthcare field	Unknown	No	No	--	Hemangio-endothelioma, right pleural	10 months
179/ U14	51	M	No	Hardware store cutting asbestos board	Yes	No	No	--	Hemangio-endothelioma, right pleural	Unknown
182/ U17	80	M	17-pack years	Motor inspector and steelworker at steel plant for approximately 35 years	Yes	No	No	--	Hemangio-endothelioma, right pleural	3 months
197/ U32	70	M	Unknown	Plumber	Yes	P	No	Iron stains: No ferruginous bodies	Metastatic pseudo-mesotheliomatous adenosquamous cell carcinoma involving right pleura; metastatic from mouth	Unknown
183/ U18	70	M	Unknown	Unknown	No	No	No	--	Metastatic pseudo-mesotheliomatous melanoma to the left lung/pleura	7 months
184/ U19	50	M	Unknown	Painter	Unknown	No	No	--	Metastatic pseudo-mesotheliomatous melanoma to the right lung/pleura	Unknown
185/ U20	82	M	No	Carpenter	Yes	P	No	--	Metastatic pseudo-mesotheliomatous melanoma to the right lung/pleura	2 months
187/ U22	68	M	Unknown	Unknown	Unknown	No	No	--	Metastatic pseudo-mesotheliomatous squamous cell carcinoma of lung; metastatic from tongue	Unknown
193/ U28	60	M	Unknown	Unknown	Unknown	P	No	--	Metastatic renal cell carcinoma, left, clear cell type; metastatic to pleura	4 months
191/ U26	64	M	Unknown	Unknown	Unknown	No	No	--	Metastatic renal cell carcinoma, left, papillary; metastatic to pleura	Unknown

Continuation of Table 2.

ID#	Age	Sex	Smoking History	Occupational History	Asbestos exposure?	Pleural plaques	Asbestosis (1982 CAP-NIOSH)	Ferruginous bodies OR Asbestos fibers (Refer to Table 4)	Pathologic diagnosis	Survival
190/ U25	69	M	Unknown	Pipefitter at paper mill	Yes	P	No	Iron stains: 34 ferruginous bodies characteristic of asbestos bodies	Metastatic renal cell carcinoma, left, poorly differentiated; metastases to R. lung, omentum, and adrenal gland	2 months
192/ U27	41	M	Unknown	Maintenance man, including painting, drywall and linoleum installation, and general repairs	Yes	No	No	Iron stains: No ferruginous bodies	Metastatic renal cell carcinoma, left; metastases to both lungs and pleura	3 months
138	61	M	50-pack years	Unknown	Unknown	No	No	--	Non-small cell carcinoma of lung	Unknown
139	65	M	80-pack years	Insulator	Yes	P	No	Iron stains: Numerous ferruginous bodies characteristic of asbestos bodies	Non-small cell carcinoma of lung	4 months
019	77	M	No	U.S. Army, custodian, lab technician	Yes	P	No	--	Peritoneal adenocarcinoma, mucin producing	8 months
168/ U03	70	F	Unknown	Unknown	Unknown	No	No	--	Peritoneal adenocarcinoma, Mullerian origin	2 months
195/ U30	82	F	60 to 120-pack years	Painter	Bystander	No	No	--	Small cell lung cancer	3 months
196/ U31	70	F	Unknown	Unknown	Unknown	No	No	--	Small cell lung cancer	Unknown
194/ U29	84	M	30-pack years	Welder, mechanic	Yes	P, R	P Grade 3-4	--	Small cell lung cancer	2 months
143	58	M	No	Building maintenance	Yes	No	No	--	Squamous cell carcinoma of lung	3+ years
141	83	M	48-pack years	Construction worker	Yes	P, R	No	--	Squamous cell carcinoma of lung	1 month
144	82	M	150-pack years	Welder	Yes	R	No	--	Squamous cell carcinoma of lung	Unknown
142	80	M	5 to 10-pack years	Boilermaker, welder	Yes	R	P Grade 4	FB above background	Squamous cell carcinoma of lung	1 month
162/ FA17	77	M	Unknown	Unknown	Unknown	No	No	FB and AF above background	Squamous cell carcinoma of lung; metastases to lymph nodes	Unknown
188/ U23	79	M	30-pack years	Automotive mechanic	Yes	P	No	--	Squamous cell carcinoma, either lung primary or metastatic from larynx (note: status-post total laryngectomy for squamous cell carcinoma of larynx diagnosed in 1990)	Unknown

Key: U: Unknown; M: Male; F: Female; P: Pathologic; R: Radiographic; FB: Ferruginous bodies; AB: Asbestos bodies; AF: Asbestos fibers

Table 3. Histologic types of 196 pseudomesotheliomatous carcinomas.

Adenocarcinoma: 150
Squamous cell carcinoma: 5
Adenosquamous (combined adenocarcinoma and squamous cell carcinoma): 9
Large cell undifferentiated: 0
Small cell lung cancer: 3
Unusual Pseudomesotheliomatous Carcinomas:
1 Adenocarcinoma of lung, mucin producing, probable Mullerian origin
1 Basaloid carcinoma
1 Calcifying fibrous pseudotumor
1 Combined adenocarcinoma of lung and biphasic mesothelioma
1 Combined adenocarcinoma of lung and basaloid squamous cell carcinoma arising from the sino-nasal region that was metastatic to the liver and skull
1 Combined small cell lung cancer and poorly differentiated adenocarcinoma
1 Combined small cell adenocarcinoma or small cell squamous cell carcinoma & mesothelioma
4 Hemangioendotheliomas
1 Metastatic adenosquamous cell carcinoma from mouth
3 Metastatic melanomas
4 Metastatic renal cell carcinomas
1 Metastatic squamous cell carcinoma from tongue
6 Sarcomatoid carcinomas
1 Squamous cell carcinoma, either lung primary or metastatic from larynx
2 Peritoneal adenocarcinomas (cases #19 and #168)

Discussion

Pseudomesotheliomatous lung cancers are rare neoplasms, most of which are primary pulmonary carcinomas that macroscopically grow like diffuse pleural mesotheliomas. Some insist that only tumors growing in a pleural distribution in which there are no primary lung masses (tumors) be included as pseudomesotheliomas, although others would accept cases where the tumor is growing predominantly in a pleural distribution in which a mass in the lung exists which may be the source of the predominantly pleural tumor.

The most frequent forms of adenocarcinoma are mucin-producing, tubulodesmoplastic, acinar, and poorly differentiated. Less common adenocarcinomas include signet ring adenocarcinoma, adenocarcinoma of type 2 pneumocyte origin, and adenocarcinoma with a papillary/micropapillary morphology. Other primary carcinomas involving the lung and which may grow like a diffuse pleural mesothelioma include adenosquamous carcinoma, squamous cell carcinoma, deciduoid carcinoma, and rhabdoid carcinoma. Other rare/unusual types of neoplasms that grow in a diffuse pleural distribution include metastatic melanoma, calcifying fibrous tumors of the pleura, small cell lung cancer, hemangioendothelioma, metastatic renal cell carcinoma, sarcomatoid carcinoma, basaloid carcinoma, and metastatic squamous cell carcinomas from the larynx and mouth, as well as combined adenocarcinomas and mesothelioma.

The primary differential diagnosis of pseudomesotheliomatous lung cancers include epithelial mesothelioma, sarcomatoid mesothelioma (sarcomatoid cases), and biphasic sarcomatoid mesothelioma. Also in the differential diagnosis

is metastatic carcinoma from a site outside the chest and rare sarcomas that grow in a pleural distribution, such as synovial sarcomas. As shown in our report, the majority of pseudomesotheliomatous cancers are primary lung cancers; specifically, adenocarcinomas. Just as there is a wide range of variation of primary adenocarcinomas of the lung, there is also a wide variation of pseudomesotheliomatous adenocarcinomas of the lung. Pseudomesotheliomatous lung cancers can also metastasize to other parts of the body, including regional lymph nodes, opposite lung, liver, bone, and brain.

Pseudomesotheliomatous lung cancers usually present with the same signs and symptoms as diffuse pleural mesothelioma. Pleural effusions are common in both pseudomesotheliomatous lung cancers and pleural mesotheliomas. Pleural fluid can be evaluated for malignant cells using cytologic, histochemical, immunohistochemical and ultrastructural techniques. The same immunohistochemical analyses can be performed on cell block specimens. Electron microscopy can easily be performed on cytocentrifuged specimens.

The immunohistochemical features that characterize primary lung adenocarcinomas also characterize pseudomesotheliomatous adenocarcinomas. In addition, the ultrastructural features of pseudomesotheliomatous adenocarcinomas are those of a primary pulmonary adenocarcinoma; namely, a neoplasm that shows short microvilli with prominent glycocalyxal bodies, rootlets, and intracellular or extracellular mucin production. With respect to mucin production, one has to remember that epithelial mesotheliomas can show histochemical staining for PAS-diastase, mucicarmine, and Alcian blue/colloidal iron. Epithelial mesotheliomas that express mucin are usually ones that show extracellular crystalloid structures. The mucin positivity of epithelial mesotheliomas is thought to be related to hyaluronic acid production. It should also be pointed out that primary pulmonary adenocarcinomas and pseudomesotheliomatous adenocarcinomas of the lung can show expression of acidic mucous substances with the colloidal iron and Alcian blue stain that is resistant to hyaluronidase digestion.

Most people in the scientific community who are familiar with pseudomesotheliomatous neoplasms have come to the conclusion that most are made up of cells that form the chest cavity. One issue is where do the cells come from that form the pseudomesotheliomatous lung cancers? The answer to that is not precisely known, although some speculate these neoplasms come from lung tissue that is present in the lung, including bronchi, bronchioles, and alveoli. Some speculate that these cells come from the lung and penetrate through the lung and into the visceral and parietal pleura where they form neoplasms that resemble mesotheliomas, although they are actually formed by epithelioid cells in the lung. Another theory is that some cases of pseudomesotheliomatous lung cancers come from pleural tissue that contains structures such as epithelioid cells and cells that form squamous epithelial cells. In studying pseudomesotheliomatous lung cancers, most

Table 4. Asbestos digestion and fiber analysis results.

Case #	Age	Sex	Occupation	Quantitative asbestos digestion analysis (per gram wet) 5-gram samples except where noted Performed in Bremerton laboratory (SPH)	Ferruginous body and uncoated fiber data per gram dry weight except where noted Performed in Tyler laboratory (RFD)
002	?	M	Unknown	LUL = 50; LLL=70 RUL = 10; RML=50; RLL=10	Not performed
003	67	M	Millwright	LUL = 35; LLL=75 RUL = 50; RML=35; RLL=175	Not performed
008	55	M	Lived in close proximity to cement plants; worked for father's pipeline business; automotive maintenance	Not performed	Left lung 833 Right lung 444
015	71	M	Iron worker	LUL = 5; LLL=10 RUL = 15; RML=25; RLL=135	Not performed
026	66	M	Construction worker, pipefitter	1.5 gram sample lung=55	Not performed
034	57	M	Unknown	Sample lung #1=1,500 Sample lung #2=800	Not performed
041	42	M	Pipefitter, HVAC Tech	Not performed	Left lung = 32,736 FB/deparaffinized wet weight
050	58	M	Sheet metal worker	LUL = 2,600; LLL=1,000 Right lobe #1=1,400; Right lobe #2=700	Not performed
056	65	M	Floor coverer	LUL = 130; LLL=400 RUL = 105; RML=270; RLL=80	Not performed
063	76	M	Pipefitter in U.S. Army	LUL = 320; LLL=135 RUL = 230; RML -65; RLL=70	Not performed
066	77	M	Plasterer	LUL = 180; LLL=190 RUL = 45; RML=100; RLL=130	Not performed
067	80	M	Asbestos worker (? job title)	LUL = 150; LLL=1,570 RUL = 1,520; RML=375; RLL=1,760	Not performed
081	65	M	Asbestos brake plant worker	LUL = 10; LLL=25 RUL = 25; RML=25; RLL=10	Not performed
088	58	M	Unknown	LUL = 20; LLL=70 RUL = 10; RML=60; RLL=55 note: there were many more thin uncoated fibers than there were asbestos bodies, indicating the concentration of asbestos was much greater than that suggested by the asbestos body concentration alone	Not performed
089	52	M	Worked at a smelter and refinery	1.5 gram sample lung=975	Not performed
091	55	M	Automotive mechanic	LUL=1,100; LLL=30 RUL=20; RML=10; RLL=10	Not performed
092	48	M	U.S. Army, Assist. VP of merchandising for drug store	LUL=<5; LLL = <5 RUL=15; RML = 35; RLL=25	Not performed
093	40	M	Mechanic, machinist	Left lung #1=830; Left lung #2=2,350 Right lung #1=700; Right lung #2=500	Not performed
095	69	M	Shipyards worker	LUL=400; LLL=830 RUL=830; RML=600; RLL=1,000	Not performed
096	63	M	Unknown	1.5 gram sample RLL=2,500	Not performed
097	64	M	Unknown	LUL=0; LLL=5 RUL=0; RML=0; RLL=5	Not performed
098	60	M	Electrician, bricklayer	LUL=20; LLL=120 RUL=230; RML=45; RLL=25	Not performed
099	85	M	Engineer for government	2-gram sample LLL=30	Not performed
110	63	M	Automobile mechanic	Left lung #1 = 0; Left lung #2=0 RUL = 0; RML=0; RLL=0	Not performed
114	54	M	Unknown	LUL=0; LLL=0 RUL=0; RML=0; RLL=45	Not performed

Continuation of Table 4.

Case #	Age	Sex	Occupation	Quantitative asbestos digestion analysis (per gram wet) 5-gram samples except where noted Performed in Bremerton laboratory (SPH)	Ferruginous body and uncoated fiber data per gram dry weight except where noted Performed in Tyler laboratory (RFD)
118	73	M	Shipyards worker and in U.S. Navy - exposed to gaskets, packing, refractories, boilers, pumps, etc.	2-gram sample left lung=785	Not performed
123	66	M	Marine machinist, railroad brakeman	N/A	Left lung 24,290 Right lung 12,222
127	80	M	Unknown	LUL=9,702; LLL=8,316 RUL=13,100; RML=13,900; RLL=13,900	Not performed
128	62	M	Unknown	LUL=400; LLL=265 RUL=480; RML=345; RLL=130	Not performed
132	60	M	Mechanic/maintenance man	Lung (lobe not specified)=100	Not performed
133	61	M	Boilerman	Sample #1=20 Sample #2=<5 Sample #3=15	Not performed
134	74	M	Unknown	LUL=4,850; LLL=2,350 RUL=2,800; RML=3,600; RLL=3,050	Not performed
136	76	M	Insulator	LUL=9,850; LLL=12,200 RUL=10,500; RML=5,450; RLL=>25,000	Not performed
137	69	M	Carpenter/joiner at boatbuilding company	LUL=1,535; LLL=1,870 RUL=3,770; RML=1,200; RLL=1,085	Not performed
142	80	M	Boilermaker, welder	LUL=80; LLL=200 RUL=1,000; RML=130; RLL=320	Not performed
146	70	M	Insulator helper (5 years)	LUL=4,330; LLL=6,250 RUL=6,300; RML=5,755; RLL=12,235	Left lung 3,565,000 Right lung 12,685,000
147	74	M	Shipyards worker (29 years)	LUL=120; LLL=680 RUL=225; RML=185; RLL=375	Left lung 7,078,000 Right lung 1,190,000
148	75	M	Shipfitter, chipper, caulker, nuclear test director	LUL=1,750; LLL=3,320 RUL=1,100; RML=250; RLL=875	Left lung 461,000 Right lung 4,265,000
149	75	M	Shipyards electrician	LUL=1,655; LLL=1,285 RUL=3,235; RML=1,875; RLL=6,250	Left lung 1,136,000 Right lung 2,862,000
150	76	M	Built kitchen equipment	LUL=130; LLL=10 RUL=125; RML=320; RLL=305	Left lung 1,588,000 Right lung 726,000
151	43	M	Batchmaker, mixer, hod carrier, pipelayer, laborer, maintenance man	LUL=260; LLL=40 RUL=60; RML=60; RLL=250	Left lung 1,128,000 Right lung 1,400,000
152	69	M	Steamfitter and plumber (25 years)	LUL=320; LLL=250 RUL=230; RML=580; RLL=400	Left lung 1,297,000 Right lung 1,160,000
153	61	M	Electrician (20 years)	LUL=532; LLL=20 RUL=25; RML=185; RLL=150	Left lung 294,000 Right lung 1,004,000
154	71	M	Wiper & oiler (3 years); insulator & pipefitter (35 years)	LUL=860; LLL=3,460 RUL, RML & RLL=unable to evaluate	Left lung 748,000 Right lung 704,000
155	62	M	Electrician (45 years)	Sample #1=80 Sample #2=210	Left lung 392,000 Right lung 453,000
156	?	M	Unknown	Left lung #1=80; Left lung #2=300 RUL=2,000; RML=1,450; RLL=2,010	Left lung 253,000 Right lung 348,000
157	64	M	Shipyards insulator & shipwright (5 years); lineman	LUL=135; LLL=85 RUL=580; RML=30; RLL=30	Left lung 324,000 Right lung 327,000
158	?	M	Unknown	Left lung #1=20; Left lung #2=45 RUL=45; RML=75; RLL=165	Left lung - not evaluated Right lung 292,000
159	59	M	Shipyards sandblaster & painter (13 years); head hooker and furnace manager at a steel plant (18 years); laborer	LUL=10; LLL=10 RUL=10; RML=15; RLL=65	Left lung 206,000 Right lung 257,000
160	67	M	Shipyards worker (3 years); boatswains mate (9 years)	LUL=0; LLL=0 RUL=0; RML=20; RLL=20	Left lung 25,000 Right lung 192,000
161	?	M	Unknown	Not performed	Left lung 183,000 Right lung 25,000

Continuation of Table 4.

Case #	Age	Sex	Occupation	Quantitative asbestos digestion analysis (per gram wet) 5-gram samples except where noted Performed in Bremerton laboratory (SPH)	Ferruginous body and uncoated fiber data per gram dry weight except where noted Performed in Tyler laboratory (RFD)
162	77	M	Unknown	LUL=<5; LLL=20 RUL=15; RML=10; RLL=85	Left lung 58,000 Right lung 174,000
163	62	M	Unknown	LUL=0; LLL=0 RUL=<1; RML=<1; RLL=<1	Left lung – none detected Right lung 87,000
164	64	M	Unknown	LUL=0; LLL=5 RUL=0; RML=0; RLL=5	Left lung 69,000 Right lung – none detected
165	53	M	Laborer, carpenter, service station manager	LUL=0; LLL=<1 RUL=3; RML=<1; RLL=<1	Left lung 54,000 Right lung 25,000
166	96	M	Boilermaker	LUL=1,675; LLL=750 RUL=2,340; RML=3,485; RLL=4,950	Not performed
173	68	M	Driller in shipyard	LUL=75; LLL=55 RUL=25; RML=0; RLL=65	Not performed
189	67	M	Sheet metal worker	LUL=250; LLL=135 RUL=30; RML=30; RLL=40	Not performed
194	84	M	Mechanic, welder	Not performed	123 FB equivalent to 2,472.51 AF/gram deparaffinized wet weight

Key: AF: Asbestos fibers; FB: Ferruginous bodies; LL: Left lung; LUL: Left upper lobe; LLL: Left lower lobe; RL: Right lung; RUL: Right upper lobe; RML: Right middle lobe; RLL: Right lower lobe; M: Male; F: Female; ?: unknown

come to the conclusion based on the evidence available that the majority of pseudomesotheliomatous lung cancers are adenocarcinomas that directly invade the pleura and many are associated with a marked desmoplastic reaction.

There is some controversy as to whether scarring causes the cancer or whether the scarring already existed, such as scarring from tuberculosis or some other type of inflammatory condition. At this point in time, most scientists would state that, in most instances, the scarring that is associated with pseudomesotheliomatous lung cancers is not pre-existing but is actually caused by the tumor itself. That is also the case with most cancers; e.g., it is thought that the scarring in breast cancer is caused by the tumor and not by some pre-existing condition.

Conclusion

As shown in our case series, there appears to be a causal/historical link between persons exposed to asbestos and the development of pseudomesotheliomatous lung carcinomas, just as there is a link between asbestos and primary pulmonary carcinomas, mesothelioma, and other asbestos-related cancers. We conclude that when we evaluated asbestos as a potential cause in these cases of pseudomesotheliomatous neoplasms, correlation with asbestos-related changes or actual presence of biological markers of past exposure indicated a link between the development of this unique tumor and exposure to asbestos in most cases within the study. In the case of pseudomesotheliomatous lung carcinomas, there also appears to be a causal link to cigarette smoking in that 109 patients (55%) had a known history of cigarette smoking, although in 64 cases the smoking history was unknown. This causal relationship is not surprising in that most cases were

primary pulmonary adenocarcinomas, which is a recognized cancer caused by cigarette smoke carcinogens. Furthermore, the combination of asbestos exposure and smoking is recognized to result in a synergistic effect on the risk for development of a lung cancer.

Competing interests

The authors declare that they have no competing interests.

Authors' contributions

Authors' contributions	SPH	RFD
Research concept and design	✓	✓
Collection and/or assembly of data	✓	--
Data analysis and interpretation	✓	--
Writing the article	✓	✓
Critical revision of the article	✓	✓
Final approval of article	✓	✓
Statistical analysis	✓	✓

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