

Brief Report

Mesothelioma in Household Members of Asbestos-Exposed Workers: 32 United States Cases Since 1990

Albert Miller, MD*

Background Mesothelioma is significant as an indicator of asbestos exposure, as a continuing major cause of death in those exposed, and as a risk following lesser exposures. One such exposure is living in the household of an asbestos worker, and coming into contact with fibers brought home on his/her body, clothing, etc.

Methods Law firms throughout the US known for their pursuit of asbestos claims were polled for mesothelioma claims brought on behalf of family members of identifiable asbestos-exposed workers. Cases with any occupational, environmental, or other possible exposure were not included.

Results This study reports 32 household-exposure mesothelioma cases, diagnosed since 1990. Relationships were wife (15), daughter (11), son (3), sister-in law (1), niece (1), and boarder (1). Occupations of the workers included shipyard (13), insulator (7), and other (12). Of the 27 pleural cases, 13 were epithelial, 5 fibrous, 3 biphasic, and 6 not specified; of the 5 peritoneal cases, 4 were epithelial and 1 fibrous. Latency was greater than 40 years in 27 cases; 6 cases were 40-49 years of age and 17 were 60 or older.

Conclusions Records from law firms were a useful source of information. Mesothelioma resulting from household exposure is a continuing problem. It is more likely to present in the elderly, after latencies of >40 years. Am. J. Ind. Med. 47:458-462, 2005.

© 2005 Wiley-Liss, Inc.

KEY WORDS: mesothelioma; household exposure; family members; asbestos-exposed workers

INTRODUCTION

The risk of mesothelioma in the United States from inhalation of asbestos fibers remains high even as new use of asbestos has largely ceased. This is attributable to the long

latency for this disease, the wide presence of asbestos in place in buildings and equipment, and the potential for this malignancy to be induced by relatively low levels of exposure. One such exposure, recognized since 1965 [Newhouse and Thompson, 1965] is asbestos brought home to family members on the hair, clothing and personal effects of asbestos workers. Review of the literature on this exposure is difficult. Many of the descriptions are of single or of a few cases; a report of the same four cases appeared in the literature a second time [Joubert et al., 1991] 24 years after the first [Anderson et al., 1976]. Family exposures are combined with building exposures (asbestos present in offices or schools) or environmental exposures as "non-occupational" exposures [Konetzke et al., 1990; Iscovich et al., 1999;

New York Medical College, Valhalla, New York and Saint Vincent Catholic Medical Center of New York-Brooklyn-Queens Division, New York

*Correspondence to: Albert Miller, Research Professor, Center for the Biology of Natural Systems, Queens College of the City University of New York, 163-03 Horace Harding Expressway, Flushing, NY 11365. E-mail: almill@svcmcnyc.org

Accepted 1 March 2005
DOI 10.1002/ajim.20167. Published online in Wiley InterScience
(www.interscience.wiley.com)

Magnani et al., 2000]. Many cases described as family members had their own, sometimes less recognized exposures [Risberg et al., 1980; Lynch et al., 1985; Hammar et al., 1989; Dawson et al., 1992; Bianchi et al., 1993; Ascoli et al., 1998; Hiyama et al., 1998]. The concern of other reports of family cases was with a possible genetic cause, looking at mesothelioma in occupationally exposed blood relatives [Risberg et al., 1980; Martensson et al., 1984; Krousel et al., 1986] who may have lived in the same household [Hammar et al., 1989].

This report of 32 cases of mesothelioma since 1990, attributable only to asbestos brought home by another resident of the household, demonstrates the continuing nature of the problem in the United States. It utilizes an under appreciated data source, the files of law firms throughout the United States which are active in the pursuit of asbestos-related claims.

METHODS

Law firms throughout the United States known for their pursuit of asbestos-disease claims were polled on three occasions over 5 years for mesothelioma claims brought on behalf of family members of identifiable asbestos-exposed workers. Of 25 firms, 15 submitted demographic and exposure information, and medical records on such claimants. Cases with any occupational, environmental (e.g., wives living in the same community as their Manville, NJ asbestos factory worker husbands), building (other than the dwelling shared with the exposed worker), or other possible exposure (e.g., smokers of Kent cigarettes, whose filters contained crocidolite asbestos) were not included. Cases from nine firms met criteria, including onset after 1990. The diagnosis of mesothelioma was based on the pathology report, confirmed by immunohistochemical staining in 29, autopsy in 2, and surgery in the remaining case. Exposure information from testimony, depositions and employment records and medical data were reviewed. Latency was estimated from year of first exposure until onset of symptoms (or of diagnosis if the former was not available). Differences in latency between wives and offspring were assessed by pooled and Satterthwaite *t*-Tests.

In the final analysis, many of the firms had gone out of existence, split and/or merged. It was not possible to obtain a total member of mesothelioma cases from them, let alone the outcomes.

RESULTS

From the files of nine plaintiff law firms throughout the United States, 32 cases of mesothelioma were analyzed who had no occupational, environmental, or other exposure to asbestos than as a household member of a worker with a clear occupational exposure. Information on demographics, diag-

nosis, and exposure are provided in Table I. Patients are ordered by date of onset of symptoms (or of diagnosis if the onset of symptoms is unclear).

Age at first exposure was <10 years in 13, 10–19 years in 5, 20–29 years in 9, 30–39 years in 2, and unavailable in 3. Mean latency was 49.0 ± 10.7 year. Latency was skewed towards greater length consistent with the requirement that the disease be manifest no earlier than 1990; 20–29 years in 2, 30–39 years in 2, 40–49 years in 12, ≥ 50 years in 15, and unavailable in 1. Latency for offspring was slightly longer than for wives, 52.9 versus 45.4 years, a difference which approached significance (0.07). Mean age at presentation was 62.3 ± 11.7 year; 17 cases were age 60 or greater.

All patients lived in the same household as the exposed worker(s). In the three cases of dual relationship (daughter and sister, daughter and wife, daughter and wife), the earlier exposure is counted. Relationships were: wives (15), daughters (11) (one stepdaughter), sons (3) (one stepson), sister-in-law (1), niece (1), and boarder (1), this last being a woman who lived in a boarding house with several shipyard workers from age 20 to 28.

Occupations of the worker who lived with the present cases were: shipyard (13), insulator (other than shipyard) (7), railroad (2), manufacture of asbestos materials (2), boiler-maker (2), steel mill (2), refinery (1), pipe fitter (1), refractory bricklayer (1), and construction (1).

Histologic classification of the 32 cases is typical of mesothelioma in general: 27 pleural (13 epithelial, 5 fibrous, 3 biphasic, and 6 not specified) and 5 peritoneal (4 epithelial, 1 fibrous). Among the 29 female cases, 24 were pleural and 5 peritoneal; all 3 male cases were pleural. Diagnosis was confirmed by immunohistochemical reactions in 29 and was based on multiple specimens reviewed by pathologists in different institutions in the remaining three.

Although information about other asbestos-related disease was incomplete, pleural plaques were present in at least 10 household mesothelioma cases, 4 of whom also had asbestosis.

DISCUSSION

Inhalation of asbestos fibers is the predominant cause of mesothelioma. The majority of cases result from occupational exposures of the patient, not infrequently far removed in time and memory. Mesothelioma resulting from household exposure to asbestos brought home on the hair, clothing, and effects of workers has been recognized since the report of Newhouse and Thompson [1965] which included seven wives and two sisters of asbestos workers among 83 cases of mesothelioma dating back to 1917. Anderson and coworkers reported four cases of mesothelioma attributable to household exposure in 1976 and reviewed the literature totaling 37 cases [Anderson et al., 1976]. Most reports have been of single or a small number of cases [Huncharek, 1986; Maltoni

TABLE 1. Demographics, Histology, Chronology, and Exposures of Household Member Mesothelioma Cases 1990–2004

Pt no.	Relationship	Year of birth	PL/PE/Hist	Age at Dx	Year of Dx	Year of death	Period Sx to death	Exposed family member			Age 1st exposure	Latency yr
								Trade	Yr began	Yr quit		
1	Wife	1938	PL/Epith	52	1990	1992	29M	INS	1956	1964	18	34
2	Wife	1929	PL/Epith	60	1990	1991	15M	INS	1947	1987	18	43
3	Daughter/ Sister	1947	PE/Epith	43	1990	1993	33M	Steel mill	1947	1972	Birth	43
4	Daughter	NA	PL/Epith	NA	1992	Alive/1996	≥6Y	Steel mill	1947	1972	1972	NA
5	Boarder	1922	PL/NA	69	1992	1992	11M	SY	NA	NA	NA	NA
6	Wife	1912	PL/Fib	80	1992	1993	3M	SY	1942	1950	20	49
7	Wife	1923	PL/Epith	69	1992	1995	30M	SY	1942	1982	30	50
8	Daughter	1931	PL/Epith	61	1994	1995	34M	SY	1943	1944	20	49
9	Wife	1918	PL/NA	75	1993	1993	3W	MF	1951	1957	20	41
10	Step-daughter	1948	PE/Epith	45	1993	NA	NA	INS	1935	1955	17	58
		1915							1954	1961	6	39
11	Wife	1921	PL/Epith	71	1993	1995	20M	SY	1941	1946	20	52
12	Wife	1920	PL/NA	73	1993	1994	5M	Steel Mill	1950	1980	30	43
13	Daughter	1936	PL/Epith	57	1994	NA	NA	Refinery	1941	1955	5	52
14	Wife	1914	PL/Epith	79	1994	NA	NA	PF	1942	1975	28	52
15	Wife	1947	PE/Epith	46	1994	1995	12M	Construction	NA	NA	Assumed 22	Assumed 25
16	Daughter	1945	PL/Epith	49	1995	NA	NA	BM	1945	1969	Birth	49
17	Wife	1930	PL/bi	64	1995	1996	12M	Ref. Bricklayer	1948	1990	18	46
18	Wife	1938	PL/Epith	57	1996	NA	NA	INS	1955	1988	17	41
19	Wife	1949	PE/Fib	46	1996	1997	12M	RR brakes	NA	NA	Assumed 22	Assumed 25
20	Niece	1941	PL/Fib	55	1997	1997	18M	SY	1955	1975	14	41
21	Daughter/ Wife	1941	PL/Epith	56	1998	Alive/1999	>21M	SY	1942	1963	1	56
								BM	1962	1980		
22	Son	1940	PL/Fib	58	1998	NA	NA	SY	1942	1945	2	55
23	Son	1939	PL/Fib	58	1998	Alive/1999	>12M	SY	1942	1945	3	55
24	Wife	1934	PL/bi	64	1998	NA	NA	INS/spray asbestos	1954	1977	20	44
25	Wife	1915	PL/Fib	82	1998/clinical	1999	1Y	SY	1935	1963	20	63
26	Stepson	1934	PL/Epith	64	1999	NA	NA	SY	1941	1944	7	57
27	Daughter	1946	PL/Epith	53	2001	Alive/2002	≥32M	SY	1941	1965	Birth	53
28	Daughter	1928	PL/bi	72	2000	NA	NA	MF	1930	1949	2	70
29	Wife	1924	PL/NA	75	2000	NA	NA	BM	1940	1959	20	56
30	Sis-in-law	1920	PE/Epith	80	2001	2001	6M	SY	1941	1947	21	59
31	Daughter	1957	PL/Epith	46	2003	NA	NA	INS	1953	1976	Birth	46
32	Daughter/ Wife	1932	PL/NA	72	2005	NA	NA	RR blacksmith	1932	NA	Birth	72
								PF	1954	1992		

BM, boilermaker; DOB, date of birth; Dx, diagnosis; Hist, histologic diagnosis; INS, insulator; MF, manufacture asbestos product; PE, peritoneal; PF, pipe fitter; PL, pleural; Refr, refractory; RR, railroad; Sx, symptoms; SY, shipyard.

et al., 1995; Schneider et al., 1996]. Two series report more than eight cases. Leigh et al. [2002] list 4,838 cases from the Australian Mesothelioma Register 1986–2000 of whom 42 “lived with/washed clothes [of an] asbestos/products worker” and 29 “lived in [an] asbestos [containing] dwelling;” no information on gender, age, relationship, etc. is provided. Roggli et al. [1997] reported that 33 of 59 female mesothelioma cases with an available exposure history were family contact only. Calendar years of exposure, onset of symptoms, or diagnosis were not provided, so that the number of cases since 1990 cannot be determined. These 59 cases were among 770 reviewed by the senior author, an expert pathologist to whom histologic materials are sent for review by other pathologists and by attorneys. The present series is similar to that of Roggli et al. in that both comprise cases from throughout the United States, many or all of which came to legal attention. The 33 household exposure cases in the Roggli series were similar to the present series in the distribution of peritoneal versus pleural cases (4 vs. 29), age, frequency of pleural plaques, (9), distribution of family relationships (22 wives, 6 daughters, 2 mothers, and 6 multiple), and occupation of household contact (10 insulators, 6 shipyard workers, 4 pipe fitters/steam fitters, 2 oil refinery, 7 miscellaneous, and 7 not available. (Family relationships and occupations of these household contacts total 36 since 3 cases had their own occupational exposures).

The identification of household exposure as the mechanism for family mesothelioma has been complicated by reporting family cases with their own occupational [Bianchi et al., 1993; Hiyama et al., 1998] or other non-occupational exposures such as neighborhood proximity to an industrial source, asbestos present in buildings of employment, or asbestos in cigarette filters. Family cases resulting from household exposure have been confounded with possible genetic predisposition to mesothelioma reported in consanguineous family members who have been occupationally exposed [Risberg et al., 1980.; Martensson et al., 1984; Lynch et al., 1985; Krousel et al., 1986; Hammar et al., 1989].

Similar to wives, daughters, and boarders, household pets are at risk from asbestos brought home by exposed workers. An asbestos related occupation of a household member was associated with mesothelioma in dogs diagnosed with mesothelioma at the Veterinary Hospital of the University of Pennsylvania [Glickman et al., 1983].

Wives predominated in the present and in Roggli's series. Anderson reported a far higher frequency of benign radiographic abnormalities in wives (48%) compared with daughters (21%), despite similar durations of exposure [Anderson et al., 1979]. This is consistent with a greater burden of asbestos in wives.

Household exposure has been suggested as the source for mesothelioma presenting at an earlier age. This was identified in 5 of 10 cases of mesothelioma presenting in

patients ≤ 40 years of age at one medical center [Kane et al., 1990]. None of our patients presented ≤ 40 years of age; only 6 cases presented in the age decade 40–49 (4 offspring, 2 wives). That more than half the cases were 60 years of age or greater demonstrates that household exposure should not be ruled out when mesothelioma is detected in an older patient.

Although household exposure is generally thought to be low level, and is often classified with other low level exposures (building, neighborhood), fiber content of lung tissue from such exposure was found to be similar to that of shipyard and most asbestos-exposed trades other than insulators, and far greater than that of building occupants [Roggli and Longo, 1991]. In contrast to men, in whom 90% of mesotheliomas are attributable to asbestos and 90% are pleural [Spirtas et al., 1986], only 20% of mesotheliomas in women are said to be attributable to asbestos and two-thirds are pleural [Spirtas et al., 1994]. The higher proportion (83%) of pleural to peritoneal mesotheliomas in the present series tends to confirm asbestos as the source.

The incidence of mesothelioma in the United States is likely declining since the early 1990s, attributable to the decreased use of asbestos [Weill et al., 2004]. Nevertheless, that these 32 (and undoubtedly other) cases of mesothelioma caused by household contact with asbestos have come to legal attention since 1990 confirms the ongoing risk of this exposure. This is consistent with the persistence of asbestos in the homes of contacts, the greater intensity of this exposure than is generally recognized, and the very long latency for mesothelioma. The predominance of women in these household contact cases suggests that such exposure may have taken place in the large percentage of women whose mesotheliomas have not been attributed to asbestos (see above).

REFERENCES

- Anderson HA, Lilis R, Daum SM, Fischbein AS, Selikoff IJ. 1976. Household contact asbestos neoplastic risk. *Ann NY Acad Sci* 271:311–323.
- Anderson HA, Lilis R, Daum SM, Selikoff IJ. 1979. Asbestosis among household contacts of asbestos factory workers. *Ann NY Acad Sci* 330:387–399.
- Ascoli V, Scalzo CC, Bruno C, Facciolo F, Lopercolo M, Granone P, Nardi F. 1998. Familial pleural malignant mesothelioma: Clustering in three sisters and one cousin. *Cancer Lett* 130:203–207.
- Bianchi C, Brollo A, Zuch C. 1993. Asbestos-related familial mesothelioma. *Eur J Cancer Prev* 2:247–250.
- Dawson A, Gibbs A, Browne K, Pooley F, Griffiths M. 1992. Familial mesothelioma. Details of 17 cases with histopathologic findings and mineral analysis. *Cancer* 70:1183–1187.
- Epler GR, Fitz-Gerald MX, Gaensler EA, Carrington CB. 1980. Asbestos-related disease from household exposure. *Respiration* 39:229–240.
- Glickman LT, Domanski LM, Maguire TG, Dubielzig RR, Churg A. 1983. Mesothelioma in pet dogs associated with exposure of their owners to asbestos. *Environ Res* 32:305–313.

- Hammar SP, Bockus D, Remington F, Freidman S, LaZerte G. 1989. Familial mesothelioma: A report of two families. *Hum Pathol* 20: 107-112.
- Hiyama J, Marukawa M, Shiota Y, Ono T, Imai S, Motohiro K, Aoki J, Sasaki N, Taniyama K, Mashiba H. 1998. Two familial mesothelioma cases with high concentration of soluble cytokeratin 19 fragment in pleural fluid. *Intern Med* 37:407-410.
- Huncharek M. 1986. Asbestos-related mesothelioma risk among railroad workers. *Am Rev Respir Dis* 134:983-984.
- Iscoyich J, Fischbein A, Witt-Kushner J, Ginsberg G, Richter E, Tulchinsky T. 1999. Malignant mesothelioma in Israel, 1961-1992. *Int J Occup Environ Health* 5:157-163.
- Joubert L, Seidman H, Selikoff IJ. 1991. Mortality experience of family contacts of asbestos factory workers. *Ann NY Acad Sci* 643:416-418.
- Kane MJ, Chahinian AP, Holland JF. 1990. Malignant mesothelioma in young adults. *Cancer* 65:1449-1455.
- Konetzke GW, Beck B, Mehnert WH. 1990. Remarks on occupational and non-occupational effects of asbestos (in German). *Pneumologie* 44:858-861.
- Krousel T, Garcas N, Rothschild H. 1986. Familial clustering of mesothelioma: A report on three affected persons in one family. *Am J Prev Med* 2:186-188.
- Leigh J, Davidson P, Hendrie L, Berry D. 2002. Malignant mesothelioma in Australia, 1945-2000. *Am J Ind Med* 41:188-201.
- Lynch HT, Katz D, Markvicka SE. 1985. Familial mesothelioma: Review and family study. *Cancer Genet Cytogenet* 15:25-35.
- Magnani C, Agudo A, Gonzalez CA, Andrion A, Calleja A, Chellini E, Dalmaso P, Escolar A, Hernandez S, Ivaldi C, Mirabelli D, Ramirez J, Turuguet D, Usel M, Terracini B. 2000. Multicentric study of malignant pleural mesothelioma and non-occupational exposure to asbestos. *Br J Cancer* 83:104-111.
- Maltoni C, Pinto C, Valenti D, Carnuccio R, Amaducci E, Minardi F. 1995. Mesotheliomas following exposure to asbestos in sugar refineries. *Med Lav* 86:478-483.
- Martensson G, Larsson S, Zettergren L. 1984. Malignant mesothelioma in two pairs of siblings: Is there a hereditary predisposing factor? *Eur J Respir Dis* 65:179-184.
- Newhouse ML, Thompson H. 1965. Mesothelioma of pleura and peritoneum following exposure to asbestos in the London area. *Br J Ind Med* 22:261-269.
- Risberg B, Nickels J, Wagermark J. 1980. Familial clustering of malignant mesothelioma. *Cancer* 45:2422-2427.
- Roggli VL, Longo WE. 1991. Mineral fiber content of lung tissue in patients with environmental exposures: Household contacts vs. building occupants. *Ann NY Acad Sci* 643:511-518.
- Roggli VL, Oury TD, Moffatt EJ. 1997. Malignant mesothelioma in women. *Anat Pathol* 2:147-163.
- Schneider J, Straif K, Woitowitz HJ. 1996. Pleural mesothelioma and household exposure. *Rev Environ Health* 11:65-70.
- Spiras R, Beebe GW, Connelly RR, Wright WE, Peters JM, Sherwin RP, Henderson BE, Stark A, Koroasznay BM, Davis JNP, Vianna NJ, Keehu RJ, Ortega LG, Hochholzer L, Wagner JC. 1986. Recent trends in mesothelioma incidence in the United States. *Am J Ind Med* 9:397-407.
- Spiras R, Heineman EF, Bernstein L. 1994. Malignant mesothelioma: Attributable risk of asbestos exposure. *Occup Environ Med* 51:804-811.
- Weill H, Hughes JM, Churg AM. 2004. Changing trends in U.S. mesothelioma incidence. *Occup Environ Med* 61:438-441.