Mesothelioma: You Do Not Have to Work for it

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Asbestos pollution is a global problem. Asbestos exposure induced mesothelioma does not require an 'occupational' type of exposure. Bystander exposures may result in earlier age of disease onset and more aggressive disease progression as described in the following 3 case reports. Diagn. Cytopathol. 2007;35:774–777. © 2007 Wiley-Liss, Inc.

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Bystander exposure can occur through contact with asbestos contaminated occupationally exposed individuals (or their belongings), through contact either with fibers resulting from the erosion of asbestiform rocks or exposure to products made with asbestos such as gaskets, brake pads, clutch pads, floor tiles ceiling tiles, roofing shingles, sheet rock, putties, insulation, and cement. Innocuous tasks such as laundry, home remodeling or auto repair can result in bystander exposure to asbestos. Bourdes et al.[1] provides a summary of asbestos levels in various environments. The levels near a US asbestos cement plant (0.6–2.2 fibers/l) are notably lower than the range for ambient air in several US cities (1–150 fibers/l) and less than that accompanying urban expressway pollution (3.3 fibers/l).[1] It is striking that a small number of New York air samples immediately after the World Trade Center Disaster showed levels in excess of the EPA hazard alert level of 70 fibers/mm^3, (i.e., 7×10^7 fiber/l) which represents a million fold increase over those listed above.[2] Ordinary vacuum cleaning, sweeping, or dusting is not effective at removing asbestos fibers which frequently become airborne when disturbed. The presence of asbestos fibers in ice from Greenland or on the moors of Yorkshire demonstrates the worldwide extent of asbestos pollution.[3]

Bystander asbestos exposure is a common but infrequently recognized risk for mesothelioma. Magnani et al.[4] provided formal epidemiologic evidence for increased risk of pleural mesothelioma both from environmental (10-fold increase) and household (5-fold increase) exposure to asbestos over the risk in nonexposed controls. Bystander exposure is often sustained by women and children who may be at increased risk for mesothelioma compared with men.[5] Recent analysis of a large population of asbestos exposed individuals revealed a significantly larger proportion of women in the mesothelioma group compared to the proportion of women in other asbestos induced disease categories.[5] Relatively little has been written about bystander exposure to asbestos in the U.S. Only 1 of 15 studies involving bystander exposure was conducted in the US,[6] with relative risk for mesothelioma ranging from 1.3 to 182. Five of 10 mesothelioma cases presenting in patients under age 40 represented household exposure to asbestos with median age at first exposure of 10 yr and median latency to diagnosis of 19 yr.[7]

Bystander types of exposure can provoke mesothelioma with variable age onsets. Recently, Miller[8] described a bystander exposure group (household members of asbestos exposed workers) consisting of 32 US cases of mesothelioma presenting after 1990 which were obtained from the records of law firms.[8] Age at diagnosis ranged upwards from 43 yr with half of the cohort older than 60.[8] First exposure to asbestos in this group ranged from birth to 30 yr with almost half of the populations first known exposure between birth and age 20.[8]

The very nature of bystander asbestos exposure implies contact of variable duration. However, short exposure is not equivalent to low exposure or to low risk. In fact, Hillerdal[3] suggests that fiber concentration during domestic exposure maybe as high as that sustained during occupational exposure. De Vuyst demonstrated that bronchial lavage fluid contains asbestos bodies (AB) at concentrations of less than 1 AB/ml in individuals without occupational or known environmental asbestos exposure.[9] How-

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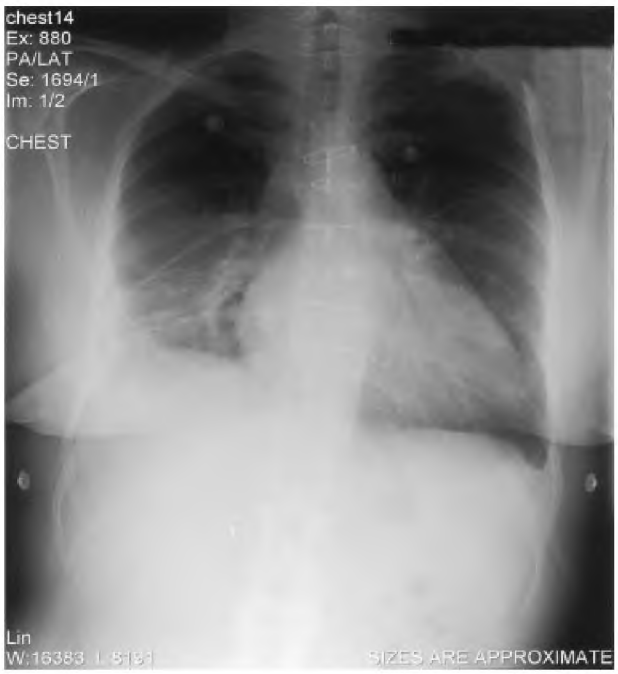

Fig. 1. The posterior to anterior (PA) chest X-ray of Mrs. X at the time of presentation. Note the asymmetric pleural scarring and or effusion. A pleural effusion with or without evident pleural scarring is almost always apparent at the time of presentation of a thoracic mesothelioma. This is frequently mistakenly treated as pneumonia or congestive heart for months causing delay in diagnosis.

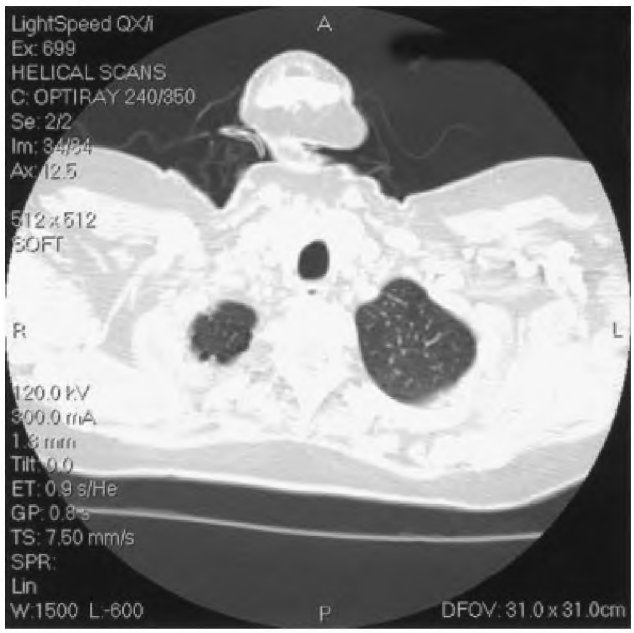

Fig. 2. This CT cut illustrates the tendency of mesothelioma to encase the lung. Although the tumor may have a "lumpy, bumpy" configuration on CT it can also present as seen in this illustration as a unilateral smooth concentric increase in pleural thickness with or without a pleural effusion.

ever, he found 1.2 AB/ml (80% of the AB formed on amosite and the remainder formed on crocidolite) in the wife of an asbestos spray insulator responsible for the weekly laundering of her husbands work clothes.[10] Fiber burdens within the lung are reflective of individual variability in alveolar retention and fiber-type dependent differences in biopersistence. Some differences in alveolar retention arise from cigarette smoking, chronic obstructive pulmonary disease (COPD), and other airway abnormalities. In addition there may be genetic differences leading to alteration in alveolar structure, function, or inflammatory response. The fact that high levels of asbestos exposure are not necessarily correlated with increased risk for mesothelioma[11] probably reflects the fact that high fiber burdens may lead to pulmonary insufficiency well prior to any possible expression of mesothelioma. Below are the case records of three women with bystander exposure to asbestos.

Case 1

Mrs. X was a 63-yr-old woman who worked from 1952–2002 as a clerk, auditor, courier, and dispatcher without known occupational asbestos exposure. She resided in a neighborhood containing a cement factory from 1939 through 1961, 1962 through 1967, and from 1996 until her death in 2004. The asbestos containing cement pipe known as Transite pipe was manufactured at this facility located within two blocks of Mrs. X's residence. Crocidolite asbestos was the fiber type primarily used in the manufacturing process which in full operation generated 10–20 tons of waste/day. Mrs. X's father worked at the manufacturing facility for 30 yr, primarily in the storeroom, handling all sorts of asbestos containing materials such as pipe covering, wallboard, and raw asbestos. As a child, Mrs. X would routinely visit her father at the job site and take him his lunch, sometimes sharing his lunch and riding her bicycle around the plant grounds. She helped with the laundering of her dad's work clothes by age 12–13.

Mrs. X presented with a right pleural effusion in March of 2002 (Figs. 1–2) and was treated for a community acquired pneumonia. Four thoracentesis procedures were performed between March and September 2002. The pleural fluid was exudative with a cytology examination negative for malignancy. She was admitted to hospital in mid September 2002 for possible thoracoscopic decortication and was found to have a markedly thickened pleura that was adherent to the underlying lung. Therefore, Mrs. X underwent a right thoracotomy with biopsy of the pleura which was markedly thickened to 1 cm and white, firm, and rubbery. Attempts at separating the lung from the pleura resulted in multiple areas of air leak. The pathology report revealed malignant mesothelioma, epithelial type. At the time of hospital admission Mrs. X complained of a 30 pound weight loss over the last yr. Her family history was significant for cancer. Three uncles

had been diagnosed with cancer (stomach, lung, and the third an unknown primary). An aunt was diagnosed with cervical cancer. All four relatives worked in the asbestos plant.

Case 2

Ms. Y was a 51-yr-old female who began working as a medical associate from 1986 until the time of evaluation in 2001, performing EKG's, assisting patients, drawing blood, and completing forms. Her father worked for a can factory and she did not help launder his clothes. He did a small remodeling project when she was 10, installing floor tile and sheetrock. The entire project took about 6 mo. She was married to an electrician from 1987–94, however, she did not launder his clothing at home. Ms. Y resided in close proximately to Mrs. X for most of her life. She recalls the grass in her yard, the tomatoes in the garden and the cars in the driveway constantly having a white dust on them. As a child, she remembers wiping the white dust from her bicycle and how the silt would build up on her bedroom furniture. She smoked up to 1/2 pack of cigarettes/day beginning at 17 and ending at age 45. She never regularly used pipe, cigar, or chewing tobacco. Two of her seven siblings had no known occupational exposure to asbestos but were diagnosed with asbestosis. In addition, another brother also reported to be unexposed had a history of asbestosis and asbestos induced pericarditis.

In February 2000 Ms. Y complained of chest pain and a chest X-ray revealed a 1.5 cm nodular density in the right mid lung field which was suspicious for a primary lung carcinoma. Also noted was linear left lower lobe atelectasis or scarring. A PET scan performed in March 2000 revealed a nodule in the right central lung field that measured 1.7 × 2 × 1.4 cm consistent with primary lung cancer. In April 2000 a thoracotomy was performed with a right upper lobectomy and node dissection. A palpable 2–3 cm sub-pleural mass in the inferior aspect of the right upper lobe was excised. Also noted at the time of surgery were pleural plaques on the parietal surface of the chest wall. A fiber burden analysis was performed and crocidolite asbestos fibers were found at a concentration consistent with an occupational exposure.

The fiber burden analysis on Ms. Y reveled levels consistent with occupational exposure even thought Ms. Y's exposure was clearly environmental. Given the shared environment between Ms. Y and Mrs. X, similar lung fiber exposures would be predicted. Asbestos bodies are frequently found in those who have sustained a bystander exposure.[12] Dodson found asbestos bodies in 13/15 and uncoated asbestos fibers on lung digestion in all 15 women with mesothelioma who had sustained a bystander exposure. An increased number of ferruginous bodies compared to the general population was seen in 4/15.[12] The high incidence of cancer in close relatives sharing the same environment of Mrs. X is remarkable. Vianna and Polan[13] reported that the frequency of a parent with malignancy was 17/52 (33%) in a cohort of women with mesothelioma resultant from a bystander exposure. Ohar et al.[5] also found a similar increased frequency of first degree relatives with cancer among both bystanders and primary exposure mesothelioma subjects (68 and 63% respectively).

Mrs. X and Ms. Y sustained a bystander exposure to asbestos and the source of the exposure is irrefutable. Chrysotile was the most frequent asbestos fiber type used in US manufacturing. Less than 5% of asbestos imported for manufacturing in the US was crocidolite. The cement factory used crocidolite. The presence of crocidolite fibers in the lungs of Ms. Y at levels consistent with an occupational exposure link her exposure and that of Mrs. X by inference to the cement factory. These individuals have atypical medical histories. More often, the source of exposure is much less apparent which is illustrated by the case of Miss S.

Case 3

Miss S was a 23-yr-old woman whose primary asbestos exposure stemmed from exposure to her fathers work clothes. Mr. S worked with asbestos as an electrician, an insulator, a mechanic, a machinist, a miller, a pipe fitter, a plumber, a steel worker, and as a welder while being employed by an aluminum can company. In 1978 Mr. S worked as a furnace operator. In 1979 he worked with the labor pool making wooden pallet boxes. He also put coils of metal in the furnace. In 1980 he installed asbestos thermal couples into furnaces. Also in 1980 he worked as an equipment operator at the can recycling division. He ran a high-low. He worked in the vicinity of the furnaces and refractory material which he swept up and hauled away daily. He used an air hose to clean up refractory material. In 1981–2002 he worked as a mechanical craft specialist. Over that time interval, he continued to work furnace tear downs (an activity performed quarterly where a jackhammer and pickaxe were used to remove and replace refractory material from the furnace). He reinsulated furnaces. He removed insulation from pipes and reinsulated them. He mixed mud from water and asbestos powder. He used asbestos gaskets and packing material several times per wk. Miss S's father believes that asbestos abatement began at the can company in 1992. He related that specially trained asbestos crews worked with the removal of asbestos at that time. Mr. S's work clothes were laundered at home. Both he and his wife laundered his clothes. Mrs. S recollected dust debris on the floor of the laundry room where his clothes sat before washing. Miss S on occasion would help with the laundering of these clothes. Miss S worked as a nursing assistant without known asbestos exposure. There was no remodeling performed while she occupied the family home.

Miss S had been born prematurely at 28–30 wk of gestation and had a three month neonatal stay in the hospital. She had a patent ductus-arteriosis that was surgically closed. Bilateral chest tubes were placed at the age of 4 mo because of a "pulmonary infection." She had mild cerebral palsy and hydrocephalus treated with a ventriculoperitoneal shunt. In June 2002 Miss S had a routine physical examination. At that time she was noted to have a history of depression, heavy menstrual cycles, anemia, hydrocephalus, mild cerebral palsy, and asthma. She was reported to have smoked half pack of cigarettes/day off and on for 6 yr. Diabetes reportedly "ran in the family" and a maternal grandmother suffered with heart disease. Physical examination revealed a pelvic mass and CT of the abdomen performed in August 2002 revealed extensive abdominal ascites with subtle suggestion of possibly early peritoneal implants. The left ovary appeared complex in its configuration. Also noted was an elliptical area of soft tissue thickening anterior to the pericardia.

Miss S was admitted to the hospital in August 2002. At that time she was a 22-yr-old white woman with a history of hydrocephalus and mild cerebral palsy. She had complaints of increased abdominal girth and a mass in the pelvis. A chest X-ray performed at hospital admission revealed scarring and a rib abnormality. The scarring was most prominent in the lingula. She underwent an exploratory laparotomy on the day of admission to the hospital. At the time of surgery extensive omental caking was noted and the pathology report returned positive for malignant mesothelioma, epithelial type. The mass affected the rectovaginal septum the cul-de-sac, almost all peritoneal surfaces including the junction of the small bowel mesentery and the bowel.

Anderson et al. reported four new cases and summarized 33 published cases of mesothelioma after a bystander exposure.[14] Twenty seven of 33 (81%) were women and 11 of 22 were diagnosed before the age of 50.[14] A report by Vianna and Polan showed that the mean age of the 52 women with mesothelioma resultant from a bystander exposure reported was 60.2 yr.[13] The mean age of mesothelioma diagnosis in both of these reports was less than that of asbestos tradesmen with primary exposure which was 66.9 ± 11.6 (mean ± SD).[5]

Haque et al.[15] have documented the presence of asbestos fibers in digests of placenta from healthy newborn infants in addition to finding fibers in lung, liver, skeletal muscle, and placenta from stillborn infants. In addition there was a suggestion that mean gestational age for infants positive for asbestos fibers was younger than that of infants negative for asbestos fibers.[15] It is reasonable to suggest that Miss 'S' was exposed to asbestos not only in her youth but also "in utero." The extensive invasion of the mesothelioma on peritoneal surfaces and the early age of onset suggest that neo natal or childhood bystander exposure may result in a more aggressive tumor type.

Tighter regulation and controls over industrial uses of asbestos has helped protect and prevent occupational exposure in industrialized nations. The current shift towards bystander exposures in countries which acted promptly to reduce exposure risk reflects both the effectiveness of the occupational regulation and weaknesses in environmental control and remediation. Asbestos pollution is a global problem. It may be of academic interest only as to whether individuals in industrialized societies could be found not to have sustained some level of exposure to asbestos. Physicians may need to consider mesothelioma among the differential diagnoses without regard to occupational asbestos exposure in women and in individuals in the 40+ age category who present with unexplained chest pain, fatigue, weight loss, unilateral pleural effusions, or asymmetric pleural thickening.

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