Case Report

A Case of Occupational Peritoneal Mesothelioma From Exposure to Tremolite-Free Chrysotile in Quebec, Canada: A Black Swan Case†

David Egilman, MD, MPH,[1]* and Lelia M. Menéndez, MA[2]

Background *Tremolite contamination has been proposed as the cause of mesothelioma in workers exposed to commercial chrysotile. The asbestos industry and scientists it has sponsored, for example, have argued that commercial chrysotile does not cause peritoneal mesothelioma.*
Method *Case report of peritoneal mesothelioma in a mill worker from a tremolite free Canadian mine.*
Results *Reports from pathology and occupational health and safety panels conclude that this mill worker developed work-related peritoneal mesothelioma.*
Conclusion *Chrysotile without tremolite can cause peritoneal mesothelioma.* Am. J. Ind. Med. *© 2010 Wiley-Liss, Inc.*

KEY WORDS: asbestos; chrysotile; mesothelioma; occupational exposure; tremolite

INTRODUCTION

One of the most contested areas of causation in occupational and environmental health concerns the ability of tremolite-free chrysotile to cause mesothelioma, especially in the peritoneum [McDonald and McDonald, 1997; Landrigan, 1998]. Case et al. [1997] assert that the presence of amphiboles, particularly tremolite, in the lungs of a cohort of workers employed in the Quebec chrysotile industry suggests that chrysotile exposure is not a cause of mesothelioma, including peritoneal mesothelioma. Instead, they maintain that amphibole fibers in the lung resulting from either previous occupational exposures to amphiboles and/or exposures to amphibole contaminants in Quebec's chrysotile mines are the likeliest explanation for mesothelioma cases. Mesothelioma cases in Quebec's mine workers have been associated with tremolite exposure, but no case of mesothelioma in a mine worker has thus far been traced to sole occupational exposure to chrysotile asbestos. Some scientists, thus, argue that exposure to chrysotile cannot cause mesothelioma [Egilman et al., 2003].

Two studies demonstrated absence of tremolite in asbestos samples taken from the Carey mines of Quebec. In 1980, Butler published a PhD thesis reporting that several asbestos fiber samples from the Carey Mine in East Broughton, Quebec, did not contain tremolite [Butler, 1980]. In 2005, scientists retained by a US asbestos product manufacturer took samples from the Carey mines and concluded that they were tremolite-free [Gunter et al., 2007]. Neither paper evaluated whether or not amosite or crocidolite-containing products were present at the mine sites.

†Karl Popper noted that although the assertion that all swans are white can never be proven, it can be disproven by finding a single black swan. A case of mesothelioma in a tremolite-free chrysotile mine worker disproves the assertion that exposure to tremolite-free chrysotile does cause mesothelioma.

[1]Brown University, Department of Family Medicine Health, Providence, RI
[2]Never Again Consulting, Attleboro, MA
*Correspondence to: David Egilman, 8 North Main Street, Suite 401, Attleboro, MA 02703. E-mail: degilman@egilman.com

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The absence of tremolite in the Carey mines provided an opportunity to determine if exposure to chrysotile alone had caused mesothelioma. We posted an advertisement in the local East Broughton newspaper requesting information on possible mesothelioma cases in Carey workers. The daughter of a lifelong Carey mine worker responded to our advertisement, and with her permission, we report her father's case of peritoneal mesothelioma. Her father, LF, was a lifelong mine mill worker who had no other asbestos exposures. An occupational history was obtained during an in-person interview and several follow-up phone calls between 2009 and 2010.

A CASE OF PERITONEAL MESOTHELIOMA IN QUEBEC

LF was born on June 28, 1923, and was raised and lived his entire life in East Broughton, Quebec. After attending secondary school during World War II, he worked picking fruit on a farm. At age 21, he started working as a mill worker at a mine that later became the first Carey mine. In 1958, this mine was closed, and he moved to the second Carey mine where he continued in the same job capacity. He worked for 25 years running and fixing milling machines and sweeping asbestos from the floor. He then worked in the mill for an additional 15 years as a yield maintenance foreman. He did not work as an insulator or on pipe coverings, which are specialty trades. The house in which he lived had no asbestos insulation, and there is no history of asbestos exposure apart from his occupational exposure at the mines. In 1990, at age 62, LF developed abdominal pain. He was diagnosed with an abdominal malignancy, had a rapid decline and died 2 months later on August 14, 1990 [Extrait du registre de sepulture, 1990]. The autopsy finding listed ''pancreatif [*sic*] carcinoma with very pronounced peritoneal carcinomatosa'' [Poulin 1990]. On September 6, 1991, three pulmonologists from Sherbrooke Hospital's Occupational Pulmonary Diseases Committee reviewed LF's case and determined that he had died from an occupational ''malignant peritoneal mesothelioma'' (our translation). They further stated: ''It is notable that there was also a poorly differentiated carcinoma of the small-cell oat-cell variety at the medullary level, but this tumor was markedly distinct from the peritoneal tumor'' (our translation) [Bégin et al., 1991].[1]

This case came to the attention of three physicians who served on the special Committee of the Quebec Ministry of Work (*Comité Spécial des presidents*) on September 20, 1991. This committee, which is responsible for certifying occupational diseases in Quebec, ''agreed with the conclusions and recommendations'' of Sherbrooke's pulmonology panel and recognized LF's ''occupational pulmonary disease'' as the cause of his death [Desmeules et al., 1991, our translation]. In accordance with legal procedure, Quebec's Board of Health and Safety in the Workplace (*Commission de la Sante de las Securitie du Travail*, CSST) subsequently reviewed the case and concluded that LF died from ''PERITONEAL MESOTHELIOMA'' [Walsh, 1991]. Together, the results of these occupational and health and safety panels demonstrate that LF's cause of death was accepted as work-related peritoneal mesothelioma. His family was granted compensation for funeral costs.

On January 28, 1995, the Celotex Asbestos Settlement Trust placed an advertisement in the *Courrier Frontenac* offering compensation for individuals who had become ill as a result of exposure to asbestos from Celotex and Carey Canada Inc. [Avis de prescription, 1995] LF's daughter filed a claim with the Celotex Asbestos Settlement Trust, and in 2003, LF's family received $8,500 from the Celotex Asbestos Settlement Trust, approximately 13 years after LF died.

DIAGNOSING MESOTHELIOMA FROM EXPOSURE TO CHRYSOTILE IN QUEBEC

We are unaware of any other case of peritoneal mesothelioma that can be traced solely to tremolite-free chrysotile exposure. Canadian researchers have not reported any peritoneal mesotheliomas in Canadian miners [McDonald et al., 1997]. Mesothelioma in the peritoneum is much less common than in the pleura [Sub-Committee on the epidemiology of asbestos-related diseases, 2004]. However, due to the small number of mesothelioma cases in Quebec, studies have generally not measured the risk of mesothelioma, especially peritoneal mesothelioma [De Guire et al., 2005], by exposure type [Lebel and Gingras, 2007]. Mortality associated with mesotheliomas of the pleura and peritoneum in Quebec cannot be directly evaluated because Quebec's death certificates do not distinguish between mesotheliomas and other histological types of pleural and peritoneal cancers [De Guire et al., 2005]. Indeed, LF's death certificate does not mention a cause of death, and the notice of death lists ''peritoneal carcinomatosa'' as the cause of death [Attestation d'une declaration de déces, 1990].

Reports that attempt to differentiate between mesothelioma and other asbestos-related diseases in Quebec have been hindered by a lack of uniform recording methods and protocols in the province. Cases that have been recognized by panels organized by the CSST, for instance, comprise only 22% of mesothelioma cases recorded in the *Fichier des tumeurs du Québec* (Quebec's tumour registry) [Sub-Committee on the epidemiology of asbestos-related diseases, 2004]. Available records provide insufficient data to draw definitive correlations between incidence of specific diagnoses and geographical sites of exposure. Mesothelioma diagnoses and mortality data, for example, are recorded according to hospitalization records in the tumor registry [Lebel and Gingras, 2007]. This archive does not provide evidence of the geographical site at which workers and other

[1] LF's daughter requested medical records, but they were never provided.

individuals may have been exposed. The fiber types to which they were exposed thus remain unknown.

McGill university studies sponsored by the Quebec Asbestos Mining Association (QAMA) have reported that mines in the ''central'' asbestos mining region of Thetford contain high quantities of tremolite, while mines in the ''peripheral'' region are low in tremolite [Egilman et al., 2003]. The East Broughton mines were not included in these studies. McGill researchers have never published the location of the mines or data supporting the contention that high and low tremolite mines exist. A number of papers sponsored by QAMA have listed varying numbers of undisclosed mines that could either belong to the central or peripheral areas of Thetford [Egilman et al., 2003]. McGill researchers claim that all but one of the mesothelioma cases found in the mining region of Thetford occurred in miners who worked in ''central'' (high tremolite) mines [Case et al., 1997]. This one case, however, had approximately the same amount of lung tremolite (101 fibers per microgram of dry lung) as the miners with mesothelioma who worked in ''high'' (119) tremolite mines. Exposure estimates in mppcf were similar for Thetford's ''central''/''high'' (298) and ''peripheral''/''low'' mining areas (325) and were, in fact, slightly higher for the ''peripheral'' area [Case et al., 1997].

In addition to the presence of tremolite, other theories have been proposed for the variability in mesothelioma rates in various chrysotile exposed populations. This variability has been attributed to the relative flexibility, ''harshness'' or ''softness'' or mixed nature of various chrysotile deposits [Langer and Nolan, 1994]. Langer and Nolan studied pulmonary tissue samples from a group of asbestos-exposed workers who died from asbestos-related diseases. They noted that ''harsh'' fibers behave more like amphibole fibers when aerosolized and tend to have greater penetration into the deeper parts of the lung and that heated chrysotile behaved like harsh fiber [Langer and Nolan, 1994]. This may explain why insulation workers who removed previously heated chrysotile have very high rates of mesothelioma. Langer and Nolan [1998] found 4 of 33 mesotheliomas that occurred in individuals whose lungs contained only chrysotile as the major commercial fiber type. They concluded that mesothelioma in humans may be induced through sole exposure to chrysotile in very high concentrations [Langer and Nolan, 1998].

Prior to November 5, 2003, mesothelioma, asbestosis and lung cancer related to asbestos exposure were not notifiable diseases in Quebec [Sub-Committee on the epidemiology of asbestos-related diseases, 2004]. Following this date, doctors who diagnosed cases of diseases caused by asbestos have been required to report it to public health authorities within 48 hr [Dougherty, 2003]. Quebec's department of health and social services (*ministère de la Santé et des Services sociaux*) recommended that this regulation be passed in order to permit epidemiological investigations to be conducted on the exposure characteristics of pleural and peritoneal mesothelioma cases [2004].

CONCLUSION

This case of peritoneal mesothelioma in a tremolite-free chrysotile mine mill worker challenges the assertion that chrysotile exposure alone cannot cause mesothelioma. Alternatively, if the previous mineralogy studies at Carey missed tremolite contamination, this peritoneal mesothelioma was caused by tremolite-contaminated chrysotile. This possibility does not preclude chrysotile being the cause or one of the causes of LF's peritoneal mesothelioma. It has been acknowledged that a higher dose of chrysotile is required to induce peritoneal mesothelioma than is the case for pleural mesothelioma [Langer and Nolan, 1998]. In contrast to the chrysotile found in a number of Carey asbestos samples, Gunter et al. found only one sample that ''could have'' contained tremolite. If tremolite was present, Gunter et al. [2007] concluded that no more than 0.2% would be tremolite. Thus, it is unlikely that a level of tremolite that was below the detection limits used by Gunter et al. would be sufficient on its own to cause peritoneal mesothelioma. Even if a low concentration of tremolite was present at the Carey mines, chrysotile was likely a cause of LF's mesothelioma.

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