LETTER TO THE EDITOR

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Asbestos Fibres in the Lungs of an American Mechanic Who Drilled, Riveted, and Ground Brake Linings: A Case Report and Discussion

Murray M. Finkelstein

Department of Family and Community Medicine, University of Toronto, Toronto, Ontario M5T 3L9, Canada
E-mail: murray.finkelstein@utoronto.ca
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In North America and Europe, the use of asbestos in friction products was discontinued before the end of the 20th century. In the developing world, the use of asbestos-containing friction products continues. In 2010, Cely-Garcia and colleagues (Cely-Garcia et al., 2012) sampled three brake repair shops located in Bogota, Colombia. Both asbestos and non-asbestos containing brake linings were sold separately or attached to a shoe. When brake linings are sold separated from the shoe, they must be manipulated to attach them to the shoe before installation. The process starts with the removal of the old brake shoe from the vehicle's brake drum. If the existing brake shoe is to be reused, the old lining needs to be removed and the old shoe must be ground to prepare it for a new lining. Riveting requires drilling holes in the linings and shoes and before installing rivets, the lining must be countersunk. The borders of the lining are bevelled. On some occasions, the entire exposed surface of the lining is ground to make it thinner. Once attached to the shoe, the edges of brake linings may extend beyond the shoe. In this case, it is necessary to cut or grind the edges to match the lining to the shoe before bevelling or grinding. The authors reported that ‘the sampling results indicate that the brake mechanics sampled are exposed to extremely high asbestos concentrations (i.e. based on transmission electron microscopy counts), suggesting that this occupational group could be at excess risk of asbestos-related diseases’.

This survey was followed by a 2015 report of the personal asbestos exposures of heavy vehicle brake mechanics in Columbia (Cely-Garcia et al., 2015). Once again, asbestos containing friction products were drilled, riveted and ground. Among workers sampled, riveters had the highest phase contrast microscopy equivalent asbestos concentrations, with 8 hour time-weighted average personal exposures ranging between 0.003 and 0.157 fibres cm\(^{-3}\). Three of 10 workers had pleural plaques on CT examination.

Elsewhere, after a 2008 survey of passenger car and heavy truck auto shops in Iran, Kakooei and colleagues (Kakooei et al., 2011) concluded that ‘it is to be expected that the auto mechanics will suffer negative health effects due to exposure to the serpentine and amphibole asbestos fibres’.
In the United States, with the advent of bonded linings and the introduction of disk brakes that use brake pads, the need to drill or grind brake linings was eliminated beginning in the 1960s (Paustenbach et al., 2003). In early 2014 I was asked by an attorney to consult in the case of an American service station owner (Mr. X) who had died of pleural mesothelioma. I report here an analysis of the lung asbestos fibre burden of this man who used the older method of stripping off old linings, followed by riveting and grinding of new linings. These results have relevance to the risk assessment of current practices in the developing world.

WORK HISTORY
Mr. X had worked as a bank executive until early 1979. Because of family issues, he left this employment and purchased a ‘full service’ garage providing automotive and truck service including the repair and replacement of brakes. At the time of purchase, there was a large supply of Bendix brake linings in stock. When brakes needed replacement, Mr. X would take the old shoes from the vehicle, find and match up the new linings, take the assembly to the brake lining machine where the old rivets were drilled out and the old lining was peeled off. Holes were drilled in the new lining and the lining was riveted to the shoe. The lining was then ground after machining the drums. Compressed air was used during the brake replacement process. Three or four brake replacements were performed daily at the shop. The family sold the garage in 1989. Mr. X had no other asbestos exposures during his lifetime.

Mr. X was diagnosed with pleural mesothelioma in 2010. The final diagnosis at autopsy was malignant pleural mesothelioma, biphasic variant, on the basis of the pathologic appearance and immunostaining of tissue.

At the request of attorneys representing the manufacturer, fibre burden analysis of lung tissue obtained at autopsy was performed in the laboratory of Dr Victor Roggli at Duke University. Portions of lung tissue were examined by scanning electron microscopy (×1000 magnification) and energy-dispersive x-ray (EDXA) analysis. There were 2540 uncoated fibres per gram of wet lung tissue. Six uncoated fibres were counted in 100 microscope fields. Three of these fibres were tremolite. Three of the fibres were not asbestos and were identified as silica, rutile, and stainless steel. A single asbestos body core was examined by EDXA, and that core was identified as tremolite.

Using data abstracted from copies of the original laboratory counting sheets, I have previously compared the fibre burden of a series of brake mechanics, measured in Dr Roggli’s laboratory, with the fibre burden of a series of unexposed control subjects from the same laboratory (Finkelstein 2008, 2013). Poisson regression is a useful methodology to compare fibre counts among groups of subjects (Finkelstein 2013). Because the groups here were small (Mr. X and 18 control subjects), Exact Poisson regression was used for the statistical analysis. The result was that Mr. X’s tremolite fibre burden was 6.6-fold higher (95% confidence interval = 1.5–23) than the mean tremolite fibre burden among the control subjects.

DISCUSSION
Bendix brake linings were manufactured from Canadian asbestos, a chrysotile asbestos contaminated with amphiboles including tremolite. The application of mechanical energy to asbestos-containing friction materials causes the release of fibres from the product and may cause thermal decomposition of many of the asbestos fibres. Nevertheless, there is evidence from fibre burden studies that asbestos fibres are deposited and retained in the lungs of brake mechanics (Churg and Wiggs 1986; Finkelstein 2013). Mr. X had elevated levels of tremolite in his lung, a marker of the inhalation, deposition, and retention of fibres of Canadian asbestos used in the manufacture of fiction products. Chrysotile fibres are cleared from lung tissue, with a half-life dependent upon fibre length (Finkelstein and Dufresne 1999), and were not detected in Mr. X’s tissues.

Asbestos-containing friction products are in use in the developing world, and some of these products continue to be imported into North America. Cely-Garcia and colleagues (Cely-Garcia et al., 2012, 2015) sampled brake repair shops located in Bogota, Columbia where asbestos containing brake linings are sold separately or attached to a shoe. They concluded that ‘this occupational group could be at excess risk of asbestos-related diseases’. Kakooei and colleagues (Kakooei et al., 2011) surveyed car and passenger heavy truck auto shops in Iran. They concluded that ‘it is to be expected that the auto mechanics will suffer negative health effects due to exposure to the serpentine and amphibole asbestos fibres’. Mr. X, an American mechanic acquired a large supply of brake linings when he purchased a service station, and used these linings over the course of 10 years in his garage.
Mr. X developed a fatal pleural mesothelioma, and the analysis of tissue obtained at autopsy revealed a substantially elevated level of tremolite fibres in his lung. Inhalation and retention of asbestos fibres places mechanics working with friction products at increased risk of asbestos-related diseases. Authorities in countries where asbestos-containing friction products are still in use should consider mandating the replacement of asbestos-containing friction products with asbestos-free alternatives. In the meantime the education of workers about safer work-practices is warranted.

**DISCLAIMER**
The author has worked as a consultant to plaintiff’s lawyers in asbestos litigation.

**REFERENCES**


