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CORRESPONDENCE

## Nonoccupational Exposure to Chrysotile Asbestos and the Risk of Lung Cancer

### To the Editor:

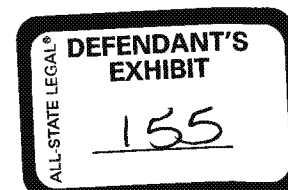
Camus et al. (May 28 issue) (1) present interesting and useful data on the risk of lung cancer with environmental exposure to chrysotile. However, the standardized mortality ratios for mesothelioma and asbestosis may be seriously confounded by occult exposure to amosite and crocidolite.

Our laboratory has analyzed a large number of lung specimens obtained at autopsy from chrysotile workers in the Thetford Mines region of Quebec, Canada, and from people in this region who never worked in the mines and mills. As a rule, only chrysotile and tremolite asbestos have been found in such studies. (2,3) However, we observed elevated levels of amosite and crocidolite asbestos (100,000, 1,000,000, and 4,300,000 fibers per gram of dry lung) in lung specimens from three women from this region who had died of mesothelioma between 1983 and 1988 and who had not worked in the mines or mills. In our laboratory, the maximal background level of amosite plus crocidolite in the general population is 10,000 fibers per gram of dry lung. These elevated amphibole levels are well within the range we have observed in cases of mesothelioma in workers who have been exposed to amosite or crocidolite, (4) and the levels in the second and third patients are typical of those we have observed in cases of amphibole-associated asbestosis. (4) These two women had asbestosis at autopsy.

The second and third patients worked in the asbestos-bag-repair operation mentioned by Camus et al., and this was probably the source of their amphibole exposure. The source of exposure for the first patient is uncertain, but it was clearly not ambient air. It appears that the cancers in these women were included in the numbers of cases of mesothelioma (and probably asbestosis) reported by Camus et al. Certainly two and probably all three cases were not nonoccupational, nor were they obviously related to chrysotile exposure.

It is generally accepted that there is a much greater risk of mesothelioma from exposure to amosite or crocidolite than from exposure to chrysotile. (5) It therefore appears likely that exposure to amosite and crocidolite was responsible for these three tumors, and the fiber levels found would also account for the presence of asbestosis. These findings suggest that the risk of mesothelioma from nonoccupational exposure to chrysotile in the population studied by Camus et al. is lower than the risk they report; there may or may not be an increased risk of asbestosis.

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Editor's note: Dr. Churg has served as an expert witness in asbestos litigation during the past five years.

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### To the Editor:

In Turkey, several villages in an area of central Anatolia known as Cappadocia have a very high incidence of lung cancer, and mesothelioma occurs frequently. (1) The residents of these villages are exposed throughout their lives to unusually high concentrations of inorganic dust, originating largely from local rocks and soils. Detailed examination of environmental samples showed that they contained several kinds of fibrous minerals, including chrysotile asbestos and nonasbestos fibers such as fibrous zeolite.

A team from our institution conducted a survey of the Cappadocian villages. (2) These villages provide a good model for investigating nonoccupational environmental exposure to naturally occurring airborne fibers. In all the villages, more than 50 percent of the men were current smokers or exsmokers, whereas, for cultural reasons, less than 0.5 percent of the women were smokers. The rate of death from lung cancer among the men was approximately 17 times that for the general population, and the rate among the women was 4 times that for the general population. The persons who died from lung cancer tended to be unusually young at the time of diagnosis, a finding that supports the hypothesis that an etiologic agent existed in the environment, with exposure beginning at birth. No case of cancer was recorded in two control villages in an area near Cappadocia. No asbestos was found in environmental samples obtained from these two control villages, whereas the content of the other fibrous minerals was found to be similar to that

in the villages in Cappadocia.

These observations indicate a direct relation between nonoccupational environmental exposure to chrysotile asbestos and the risk of lung cancer. I believe that relaxing our vigilance with respect to the suggestions of the Environmental Protection Agency (EPA) for preventing harmful exposure to chrysotile asbestos would be unacceptable.

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#### To the Editor:

Camus et al. conclude that the EPA overestimated the risk of lung cancer from nonoccupational exposure to asbestos and state that they did not assess the risk of mesothelioma because of problems with the accuracy of historical death certificates. In fact, the investigators identified two excess deaths from asbestosis and seven excess deaths from "pleural cancer," as compared with no deaths from either cause in the control population. Among 2242 women, 9 died from nonoccupational exposure to asbestos. This represents an unacceptable public health risk.

The significantly lower standardized mortality ratios for death from all causes (standardized mortality ratio, 0.91; 95 percent confidence interval, 0.87 to 0.95), death from circulatory diseases (standardized mortality ratio, 0.89; 95 percent confidence interval, 0.83 to 0.94), and death from respiratory diseases (standardized mortality ratio, 0.81; 95 percent confidence interval, 0.66 to 0.98) in the study population as compared with the control population raise the question of whether the control population had higher rates of cigarette smoking than the group of French-Canadian women who lived in the mining areas. Given the multiplicative interaction between cigarette smoke and asbestos for the sole outcome variable of interest in this study, the lack of information on smoking is a major flaw.

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#### To the Editor:

Camus et al. found no measurable excess risk of lung cancer among women in two chrysotile-asbestos-mining regions, but there are opposing opinions about whether there is a threshold level for safe exposure. The no-threshold concept is inspired by the EPA's view that a single fiber can cause cancer. But this theory is unproven. (1) The extensive marketing and use of chrysotile asbestos is based on studies that failed to demonstrate an increased risk among people exposed to low doses. (2) These findings have been advanced as proof of a threshold for safe exposure to chrysotile. (2) We suggest that a possible reason why most epidemiologic studies failed to detect an increased risk among people exposed to low doses, even if such an increase actually existed (type II error), is that the power efficiency of the statistical procedures used was insufficient. (3) Thus, the issue of a threshold for safe exposure to low-dose chrysotile may not be resolvable in practice.

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## To the Editor:

In an editorial accompanying the report by Camus et al., Landrigan attempts to explain the low rate of mortality from lung cancer among women in the asbestos-producing areas of Quebec on the basis of particle size and the nonrespirability of chrysotile asbestos. (1) However, ample data show that asbestos aerosols in the chrysotile mills of the eastern townships contained high concentrations of respirable fibers. On the basis of the "best evidence" of cause of death, 26 of 178 deaths among workers in the processing facilities in Thetford Mines, Quebec, were due to asbestosis. (2) This 14.6 percent rate of mortality from asbestosis is virtually the highest reported in modern times. Furthermore, the standardized mortality ratio for lung cancer was 2.52 (28.0 observed deaths divided by 11.1 expected deaths). Unless Landrigan is proposing that other agents were responsible for the excess cases of lung cancer and asbestosis, one would conclude that these workers inhaled chrysotile fibers. The generated chrysotile dust was respirable.

With the use of the membrane-filter technique and the Occupational Safety and Health Administration-National Institute for Occupational Safety and Health method of air assay to determine fiber levels in five of these mills, analysis of 97 samples obtained in 1973 showed that fiber levels in the mills' air ranged from 5 to 56 fibers per milliliter of air, for fibers longer than 5  $\mu$ m. The mean levels ranged from 9 to 35 fibers per milliliter of air. (2) Again, respirable fibers were present in these environments and at high concentrations.

It has long been known that in the various chrysotile-using industries, there are aerosols with different size distributions in the work environments; there are important differences in the physical and chemical properties of fibers as well. (3,4) There are also considerable data on chrysotile's degradation in a biologic host and subsequent detoxification. (4) The existence of a threshold cannot be proved, but a change in the exposure-response slope at low doses must certainly take place. (5)

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Editor's note: Dr. Langer has served as an expert witness in asbestos litigation during the past five years.

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**To the Editor:**

Landrigan is wrong in concluding that "a more than sevenfold mortality rate... from pleural cancer in mining areas, as compared with nonmining areas, corroborates an enormous body of literature showing that Canadian chrysotile... is a potent carcinogen." This mortality rate (seven cases) is entirely explained by the few cases among women in the area who had occupational exposure to amphiboles in the manufacture of gas masks, (1) the repair of burlap bags that contained imported fibers, (2) and possibly, in one case, the tremolite brought home on miners' clothes. (2) Seven such women received workers' compensation in Quebec during the period of the study by Camus et al. Indeed, there is now a scientific consensus that chrysotile asbestos is not a cause of malignant mesothelioma, even among chrysotile-asbestos miners and millers. (1) Reasonable caution should continue to be used in exposing workers or bystanders to chrysotile, but if the levels of exposure currently recommended by the Occupational Safety and Health Administration and the National Institute for Occupational Safety and Health can be maintained, public health workers can concentrate their work on lung cancer where it belongs: on smoking.

With respect to women in the mining area, it has been established that the content of chrysotile and tremolite in the lungs is directly proportional to the number of years lived in the mining region and inversely proportional to the distance between the place of residence and the mining region. (2) In fact, these women were exposed to levels of chrysotile as high as 1 fiber per milliliter of air as recently as one month in 1984. (2)

Editor's note: Dr. Case has served as an expert witness in asbestos litigation during the past five years.

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## To the Editor:

Landrigan misleads readers with the statement, "Clinical and epidemiologic studies have established incontrovertibly that asbestos causes cancer of the lung, malignant mesothelioma of the pleura and peritoneum, cancer of the larynx, and certain gastrointestinal cancers." To prove his point, he cites only one report. The cohort cited by Landrigan is only one of many asbestos-exposed cohorts described in the medical literature. That cohort has an atypical pattern of lung cancer, as compared with other cohorts. Our review of mortality from gastrointestinal cancer in occupational-cohort studies (1) has shown that there is little evidence that asbestos causes gastrointestinal

cancer. Similarly, there is a body of literature that indicates that there is no increased risk of laryngeal cancer. (2,3) Landrigan presents a biased view of the literature in an attempt to discredit the interesting and valuable contribution of Camus et al.

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Editor's note: Drs. Morgan and Goodman have served as expert witnesses in asbestos litigation during the past five years.

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### The authors reply:

#### To the Editor:

Some of the correspondents attribute to us inferences we did not make. We did not conclude that chrysotile asbestos is not carcinogenic, nor did we discuss the regulatory implications of our findings. We observed that the EPA's model greatly overestimated the risk of deaths from asbestos-induced lung cancer in our study population and that the model "may also overestimate the risk... in other populations with nonoccupational exposure." In the absence of any other published validation of the EPA's model in a population with nonoccupational exposure to asbestos, and given the fact that the model was based on a number of unverified and conservative assumptions, this statement seemed fairly restrained to us.

With regard to Demiroglu's letter, the much higher rates of lung cancer and mesothelioma in the populations of some Turkish villages than in our study population are generally attributed to exposure to erionite (fibrous zeolite) rather than chrysotile asbestos. (1) Sokas misunderstood the following aspects of our study: 2142 was the number of deaths, not the size of the population; there were deaths from asbestosis and mesothelioma in the control population; and both the control and the exposed populations consisted predominantly of small-town French-Canadian housewives with similar socioeconomic status and lifestyle. Furthermore, we presented some data on smoking habits and argued that confounding could not have accounted for the large discrepancy between the EPA model's prediction and the observed relative risk of lung cancer.

We agree with Costas et al. that the study had low statistical power to detect small risks; this was conveyed by the wide confidence intervals for our risk estimates. Our study would, however, have detected a relative risk as large as that predicted by the EPA's model. Churg's suggestion that the cases of pleural cancer and asbestosis were attributable to occupational rather than nonoccupational exposure is a possibility that will be explored in our ongoing research.

There are many possible explanations for the EPA model's overestimation of the risk of lung cancer in Quebec's chrysotile-mining towns. Our report offered six for consideration, and the correspondents' letters and Landrigan's editorial added others. At this time, all the explanations are speculative. We tend to disagree with the hypothesis that asbestos fibers in the air of mining towns were too large to be respirable, because, among other things, the main source of asbestos pollution in the mining towns was not the mines but the mills, which involved air-intensive processes designed to retain larger fibers and expel smaller ones.

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## To the Editor:

Langer ignores the pivotal point that the size distribution of airborne asbestos fibers in the mining areas of Quebec is very different from that encountered in any setting in the United States. This disparity provides the most plausible explanation for the difference in the risk of lung cancer in these two environments. In Quebec, exposure to asbestos involves crude, unprocessed asbestos, and many of the fibers are too large to be taken into the alveoli. In contrast, the asbestos in American industries, schools, and office buildings has been carded, spun, and woven. In these high-energy manufacturing processes, fiber bundles are broken, and millions of shorter, thinner, respirable fibers are created. It is probably this difference in the size distribution of fibers that accounts for the 10-fold to 50-fold difference in the risk of lung cancer reported between miners in Quebec and asbestos-mill workers in South Carolina. (1)

To be sure, there are respirable asbestos fibers in the Quebec mining townships. Although relatively few in number, they are responsible for the excess mortality from "pleural cancer" (probably mesothelioma) and asbestosis observed among women there. The apparent paradox of an excess risk of pleural cancer in the absence of lung cancer in these women is explained by a well-characterized difference in the dose-response relation between asbestos exposure and these two types of tumor. (2)

Morgan and Goodman are highly selective in their reading of the literature on the risk of gastrointestinal and laryngeal cancer in persons exposed to asbestos. The International Agency for Research on Cancer considers chrysotile asbestos a cause of gastrointestinal as well as laryngeal cancer. (3) Also, contrary to Morgan and Goodman's interpretation, the study they cite by Newhouse et al. (4) found dose-related excess mortality for both these cancers.

Case is inaccurate in his claim that chrysotile asbestos from Canada is not a cause of mesothelioma, and his assertion that there is a scientific consensus on this point is not true. (5) Also, he is disingenuous in his one-sided quest for factors other than chrysotile that would explain away the observed sevenfold excess of mesotheliomas among women in the chrysotile-asbestos-mining areas of Quebec. Experimental as well as epidemiologic studies have shown conclusively that Canadian chrysotile is fully capable of causing malignant mesothelioma, (5) and the International Agency for Research on Cancer acknowledges that chrysotile is a cause of mesothelioma. (3)

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