Risk from Exposure to Asbestos

In the light of the Environmental Protection Agency's proposed ban on the remaining uses of asbestos, it should be of interest to *Science* readers that there is a significant error in certain risk estimates of low-level asbestos exposure.

We report a mistake we discovered in the mesothelioma risk assessment portion of the National Research Council (NRC) report *Asbestiform Fibers: Nonoccupational Health Risks* (*1*). The report's authors proposed, on the basis of the analysis of Peto, Seidman, and Selikoff (*2*), a cumulative incidence function, $I(t,d) = cd(t - t_0)^k$, for equation 7 (p. 209) of the report, where t is age; $t - t_0$ is the time since first exposure at age t_0; cd is b, a constant depending on the type of asbestos exposure for workers exposed at dose level d; and k is a constant.

The values of the constants k and b (and hence c) were intended to be chosen from those calculated by Peto *et al.* by using maximum likelihood fitting to several data sets, including Selikoff's 1979 data (*3*) on insulation workers.

Unfortunately, the analysis of Peto *et al.* seems to have been misread, and as a consequence the lifetime risk of mesothelioma has been consistently underestimated by a factor approaching 20. Peto *et al.* fit observed death rates to the function $b(t - t_0)^k$ and found, for example, that when k is 3.2 and b is 4.37×10^{-8}, the Selikoff data are represented. The NRC chose these values of k and b for direct insertion in equation 7 to illustrate the cumulative incidence function, despite the fact that the Peto *et al.* death rate is the time derivative of the function $I(t,d)$. If the values of b and k are as determined by Peto *et al.*, then the resulting cumulative incidence function (cumulative death rate in the absence of competing causes) becomes $I(t,d)$, which is equal to $(t - t_0)^{k+1}\ cd/(k + 1)$ or $(t - t_0)^{k+1}\ b/(k + 1)$, rather than equation 7.

To grasp the magnitude of this correction, we observe that lifetime risk of mesothelioma, calculated (presumably incorrectly) on page 221 of (*1*) for an admittedly hazardous exposure profile, is as follows: school risk, 21×10^{-6}; background risk, 46×10^{-6}; and total risk, 67×10^{-6}. These become, after correction, school risk, 399×10^{-6}; background risk, 800×10^{-6}; and total risk, 1199×10^{-6}.

A major implication of this correction is that estimated lifetime mesothelioma risks are nearly 20 times larger than those shown in the NRC report. Therefore, mesothelioma risks would appear to dominate those of lung cancer for the exposure profiles illustrated in chapter 7.

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Table 7.2 Estimated individual lifetime risks from a continuous exposure to asbestos at 0.0004 fiber/cm^3 (a median dose) or 0.002 fiber/cm^3 (a high dose).

Disease	Exposure group	Estimated individual lifetime risk ($\times 10^6$)	
		Median exposure (0.0004 fiber/cm^3)	High exposure (0.002 fiber/cm^3)
Lung cancer	Male smoker	292	1459
Lung cancer	Female smoker	105	524
Lung cancer	Male nonsmoker	27	132
Lung cancer	Female nonsmoker	14	68
Mesothelioma	All groups	156	780

Response: Aroesty and Wolf are correct in pointing out an error in the calculation of mesothelioma risk due to asbestos exposures in the National Research Council (NRC) report *Asbestiform Fibers: Nonoccupational Health Risks* (*1*). The error was in using the simple (annual) incidence function for risk rather than the cumulative incidence function. As a result, equation 11 on page 216 of the NRC report should have read:

$$L = c(0.004)\ (73)^{k+1}/(k + 1)$$

rather than

$$L = c(0.0004)\ (73)^k$$

Using the correct function increases the estimated lifetime risks for mesothelioma by a factor of 17.4. Aroesty and Wolf mention that the corrected mesothelioma risks would now dominate those of lung cancer in the environmental estimates made in the NRC report (table 7.2). This, however, is not the case because the published lung cancer risks were also understated. A multiplier of 4.56 was used to adjust risks for mesothelioma arising from occupational exposures of 1920 hours per year to risks from general environmental exposures of 8760 hours per year. This was not done for lung cancer. Using this same multiplier to estimate lifetime risks for lung cancer resulting from asbestos exposure increases the estimated projections by a factor of 4.5.

Incorporating these corrections increases the estimated risks of both lung cancer and mesothelioma (*2*). The table above is a correction for table 7.2 in the NRC report.

It should also be pointed out that when values of k and c are used which reflect the correlation between their measures, the range of risk estimates in table 7.2 of the NRC report is greatly reduced.

The NRC regrets these errors and urges persons working with the risk estimates to note the new values in the table above. We thank Aroesty and Wolf for calling attention to this matter.

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The Vinogradov Expedition: Why Did the United States Miss the Boat?

As mentioned by Charles Petit in his article "Red tape snarls Soviet research ship" (News & Comment, 10 Oct., p. 145), I was the sole foreign scientist aboard the Soviet research vessel *Akademik Aleksandr Vinogradov* on the leg from Hilo to San Francisco (Bill Siapno, of Deepsea Ventures, Inc., came aboard at San Francisco at the last minute). Petit's article is accurate but tends to obscure the basic question: "Why was only one American on board?" The answer goes far beyond the fact that the Soviets had difficulties scheduling periods of "R & R" in American ports and in Japan. The story

begins in Washington, D.C., with events (or nonevents) that transpired in Foggy Bottom in the late winter of 1984. The mystery is not what happened, but why.

Several U.S. government agencies were formally invited to join the Vinogradov Expedition at least 1 year before the ship left port at Nakhodka (Vladivostok, U.S.S.R.), on 15 June 1986, but they failed to act on the invitation. At least one U.S. Geological Survey marine geologist received a personal invitation but was denied permission to attend by the USGS. It was he who started the chain of communications that led to my invitation to participate. In my search for travel funds, inquiries at two National Oceanic and Atmospheric Administration offices, the Minerals Management Service, and the Manganese Crust Project Office in Honolulu, and elsewhere brought the same response: "Vinogradov Expedition? Never heard of it!" The story was the same at the International Programs Office of the National Science Foundation.

As a geologist committed to and involved in international scientific cooperation since my tour with Harry Truman's Point Four Program in the Philippines in the 1950's I deplore what appears to be a hidden bottleneck somewhere in Washington, D.C., that results in the failure of international scientific projects and can even prevent usually cognizant government agencies from knowing that opportunities exist. I hope that this letter will arouse righteous indignation in the right quarters and that this bottleneck can be broken. Where are the champions of international scientific cooperation who believe in the role of scientists as forces for good in a world sadly in need of goodwill on all sides? Let us not miss golden opportunities like the Vinogradov Expedition again.

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Symbiosis

Once again, and with customary wit and eloquence, Daniel E. Koshland, Jr., has, for the most part, put biological allusion to effective use in his analysis of science policy, in this case concerning the sources and sinks of university research funds (Editorial, 31 Oct., p. 525). However, in the interest of clarifying terminology, some comment on the sense in which he uses the word "symbiosis" is in order. As any ecologist worth his or her salt will, of course, recall, "symbiosis" refers to an intimate association between (usually) two organisms, frequently involving the acquisition of food, and encompasses three major types of interaction: "commensalism," in which one partner gains while the other neither benefits nor loses in the relationship; "mutualism," in which both partners benefit; and "parasitism," in which one partner benefits at the expense of the other. Therefore, the phrase "The shift from symbiosis to parasitism . . ." is not only imprecise but constitutes a redundancy, since parasitism *is* a symbiosis. In keeping with the overall sense of the essay, "mutualism" would seem to be meant here rather than "symbiosis." This misappropriation of the latter, more general term appears to be rather widespread in both popular and professional publications.

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Basic Energy Research

Mark Crawford, in his News & Comment article "R&D budgets: Congress leaves a parting gift" (31 Oct., p. 536), shows that "Most basic research programs have emerged from the agonizing budget drama in good shape." Included in those cited is the budget for the Basic Energy Sciences program of the Department of Energy, as follows: "Basic energy research expenditures also are rising—to $536.67 million, $33 million above the level recommended by the House Appropriations Committee and far above the $441.3 million recommended by the Administration."

Referring only to the budget bottom lines without attention to the internal details can be misleading. In its final action on the Basic Energy Sciences budget, Congress provided $102 million for projects, mainly university buildings, not requested by the Administration; reduced Administration requested items by $6.7 million; and specified the expenditure of an additional $11.4 million for purposes not included in the Administration's request.

The net result is not a program of research being increased by 22% compared to that proposed by the Administration, as could be inferred by the budget totals cited in the article. Nonetheless, we are pleased that in most aspects the Administration's proposed program is intact and funded so as to allow a strong program to go forward.

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