definitions for asbestos and other health-related silicates

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REFERENCE

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In the villages of Karain and Urgup in Turkey, where asbestos exposure is limited to general environmental exposures, fibrous zeolites such as chabazite, erionite, and ferrierite are suspected agents. It has been reported that the 575 inhabitants of Karain suffered 11 deaths from pleural mesothelioma in 1975 and 1976, and there were 5 cases of fibrosing pleurisy. In the previous five years there had been 25 cases of mesothelioma [*86*].

It has been reported that radiation therapy can induce mesothelioma in humans [*85*].

Cancers of the Gastrointestinal Tract

A number of cases have been reported, but statistically significant relationships between asbestos exposure and cancers of the digestive tract have not been established with a proven degree of certainty [*68*]. Table 4 presents some data on their incidence [*89–93*].

Studies on ingested asbestos or on asbestos in drinking water deal with concentrations in excess of 100 000 fibers per litre. To put this level of risk into perspective, 100 000 fibers/L is approximately 1 ppb. The EPA's position on the use of asbestos-cement pipes for the transportation of drinking water is as follows [*94*]:

> The health risk associated with use of any of the pipe systems discussed would indeed be very small. The general order of increasing health risk for nonaggressive water would be asbestos cement less than cement lined, less than polyvinyl chloride, vinyl coated, epoxy-coated, [and] other resin base coated, with coal tar coated the greatest.

Dose-Response Relationships

During the summer of 1981, the Ontario Royal Commission on Asbestos held hearings [*64*] during which the following researchers testified about the existence of a dose-response relationship applicable to asbestos exposure: P. Enterline, who had studied the asbestos textile industry in the United States; H. Weil, who spoke on the asbestos cement industry. J. C. McDonald, known for his studies

TABLE 4—*Gastrointestinal cancer in workers occupationally exposed to asbestos.*

Study	Observed Deaths	Expected Deaths
Selikoff et al (1979) [*89*]	3	3.1
	3	2.8
Rubino et al (1979) [*90*]	4	4.8
	15	14.8
Peto et al (1977) [*91*]	no increased incidence	
Meurman et al (1977) [*92*]	no increased incidence	
Weill et al (1979) [*93*]	no increased incidence	

in the asbestos mines and mills of Quebec Province, Canada; and G. Berry, who had studied the textile workers in the United Kingdom. It was assumed, for purposes of the hearings, that case studies (as opposed to epidemiological studies) were limited in value and might be misinterpreted by the media. It was also assumed that determination of valid dose-response relationships would allow the establishment of a threshold limit of acceptable asbestos exposure.

Berry stated in his testimony that the concept of a threshold limit value implies that there exists a particular dose that is completely safe because the body's defense mechanisms will react appropriately and sufficiently. If such is indeed the case, and if the threshold is known, then we need only reduce the exposure to the threshold limit value to avoid related diseases.

It is also possible to theorize that for a zero dose, the response must be zero; if there is no known asbestos, it is unlikely that there will be asbestos-related disease. This, of course, is only an abstract concept since asbestos is omnipresent in the earth's crust. Even if all industrial activity were closed down, there would still be a measurable concentration of asbestos in the environment coming from natural sources.

In the case of asbestos, the possibilities in epidemiology of determining the dose-response relationships have diminished because the exposure levels have decreased to the point where, even at a level of 20 fibers/cm^3 (a level no longer acceptable today), it is no longer possible to detect an increase in the risk of pulmonary cancer. To evaluate the level of risk incurred nowadays (for exposure levels well below 20 fibers/cm^3) it is necessary to resort to data extrapolation.

During the 1981 hearings [*64*], in referring to his studies in the asbestos mines and mills of Quebec Province, J. C. McDonald made the following statement:

> It is impossible for a study of this scale to detect an increase in risk at exposure levels considered acceptable. This stresses the need to study different models of exposure-response (dose/response) [relationships]. We do not conclude that there is no risk, and this point must be insisted upon. We conclude that there is a risk but we cannot demonstrate it. In view of this situation, the choice of a dose-response curve becomes important. The most convenient curve being a straight-line relationship, we must accordingly assume the fact that such a relationship implies the existence of an excess of mortality attributable to exposure at low levels.

On the subject of the linearity of the dose-response curve, in the same hearings [*64*], H. Weill testified as follows:

> Most persons who have studied the available dose-response data are of the opinion that the existence of a linear dose-response [relationship] for cancer can neither be proven nor disproven. If the data are presented graphically [Fig. 1], it is obvious that the cumulative normal curve is not straight. By definition, a linear response curve would have to go through the [point of] origin, and this would imply that anywhere beyond zero exposure there would be an increase

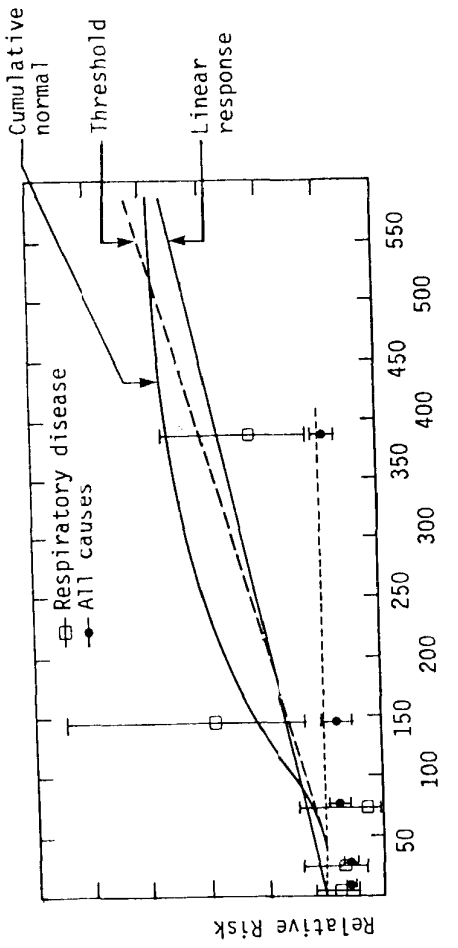

FIG. 1—*Relative risk (observed risk/expected risk) with a margin of error of 5% per average exposure for each group of five exposures (after Weill* [93])

in risk. However, the available data do allow us to trace other curves, such as the cumulative normal (or logistic) curve. It has been observed that this curve, at the lowest levels of exposure, is flat (horizontal), and further from the origin, it slopes upward until it again reaches another horizontal plateau for higher and longer exposures.

What we are unable to determine is whether or not the curve indicates that, for the zone immediately beyond zero exposure, there is a response corresponding to each period of exposure, that follows a period of nonexposure.

I mean that this curve is not traced with the aim of making such a demonstration, but that, mathematically, the existence of such a curve would imply an increase in risk.

Some could say, for example, that this logistic curve is in fact a line setting out a threshold, and that by staying beneath a given exposure level there is no measurable risk, and that, consequently, the existing risk is comparable to the risk implicit in our daily lives. I do not state that this is *my* opinion, but it is certainly an opinion that could follow from such observations. Finally, the linear dose-response line may be considered a true threshold [shown as a dotted line in Fig. 1]. This establishes a fixed level of exposure corresponding to zero risk, and an increase in risk occurs only beyond this fixed level of exposure. The available data also agree with this type of curve.

The National Institute for Occupational Safety and Health (NIOSH) has defined an acceptable risk as a measured level of exposure that corresponds to a known degree of risk accepted by society. On the subject of acceptable risk, McDonald, again in the 1981 hearings [*64*], presented the following opinion:

> It is still difficult to take the risk to the public seriously because their exposure is much lower than [that of] those in the workplace. On the other hand, there is a problem: that is the impressive number of people involved.
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> If the linear dose-response relationship is accepted, it must also be accepted that the risk to the public from asbestos is only one of the 10 or 100 million dangers possibly associated with, for example, riding the London subway; but it so happens that there are about 100 million people who do that every day. In terms of social impact, we may possibly say that the fact of taking the subway increases the number of cancers in Great Britain by 1 or more per year—I don't really know.
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> As you can see, it appears to me to be totally out of proportion to consider this kind of risk when compared against another risk, infinitely greater, which is to sit next to a smoker, and here I don't mean the risk taken by the smoker himself. If you seek a scientific estimate of the risk, measure the exposures and plot them on the dose-response curve and you will know what to expect. There is no better scientific answer.

M. Lesage, in the same hearings [*64*], presented the following opinion:

> If the results of scientific research, in terms of human lives, indicate death and disease for the asbestos worker, then the production of this fiber must be banned.