

cancer as "the only primary concern." We agree: it is also desirable to set priorities for chemicals that cause other toxicological problems. In both cases it is counterproductive to focus on quantities that are minute relative to their toxic level. Although our work focused on cancer, our methods are also relevant to other biological end points, including reproductive damage. Ranking priorities among possible teratogenic hazards is important, especially since fully one-third of the 2800 chemicals tested in laboratory animals have been shown to induce birth defects at maximum tolerated doses (1). Humans are ingesting enormous excesses of natural chemicals compared with man-made ones. For example, we ingest about 10,000 times more of nature's pesticides than man-made pesticide residues (2). Thus, one priority should be to estimate whether their toxicological effects might be in about the same proportion. There is no convincing evidence, either epidemiological or toxicological, to suggest that pollution is likely to be of great teratogenic interest relative to the background of natural chemicals.

Silbergeld's reference to dioxin pollution seems to imply that new incinerators should not be built until we know that dioxin poses no harm "to people who smoke, eat certain foods, sunbathe, or otherwise engage in risky business." Such an approach is impractical toxicologically and is an invitation to paralysis. To attempt to avoid all exposures that might cause some type of harm to someone under some circumstances ignores the background of natural hazards, the benefits of technology, and the hazardous side effects of the alternatives when some technology is eliminated. Is dioxin of importance at the tiny levels people are exposed to from incinerators when compared with the "risky business" people are already engaged in? Silbergeld's letter has prompted us to compare dioxin and alcohol in terms of the exposures to humans relative to the dose levels that have been shown to be teratogenic to mice in laboratory experiments. Unlike dioxin, alcohol is a known, and important, human teratogen. The teratogenic dose of alcohol for mice is more than a million times greater than the teratogenic dose of dioxin, similar to the difference in carcinogenic doses for the two chemicals. However, because the dose of alcohol in a bottle of beer is very high, drinking a daily beer would pose a possible teratogenic hazard about the equivalent of eating a daily kilogram of dirt contaminated with 1 part per billion of dioxin. Soil ingestion is considered by government regulatory agencies to be the main possible route of exposure (3). Given the information available concerning Silber-

geld's example, our highest priority should be to warn people about the carcinogenic and teratogenic hazards of smoking and alcohol and of the carcinogenic hazards of sunbathing and to investigate the dietary imbalances that appear likely to be major causes of cancer.

Silbergeld laments the quality of exposure data. Yet our society has made an enormous effort to measure exposures to man-made pollutants and to regulate them at a large economic cost. We have turned up remarkably little of public health interest aside from occupational hazards. Additional measurements of parts per billion or per trillion of man-made pollutants do not seem likely to make a major contribution.

Silbergeld states that the public is concerned with more than "bare" calculations of health risks. That may be, but it is the job of scientists to provide the best estimates that they can about possible hazards. This includes putting worst-case estimates of hypothetical human risks in perspective. Our work suggests that traces of pollutants are likely to be of only minimal concern relative to the background of natural chemicals. Epidemiological evidence indicates that there is no epidemic of cancer (other than that due to smoking) or of birth defects.

The biological understanding of the causes of cancer and birth defects is progressing remarkably rapidly, considering the complexity of the problem. Silbergeld's suggestions are not likely to change the priorities of the many accomplished scientists working in this area.

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3. D. J. Paustenbach, H. P. Shu, F. J. Murray, *Regul. Toxicol. Pharmacol.* **6**, 284 (1986).

**Response:** The criticism by Silbergeld should primarily be addressed to the risk management procedures of the federal government and society in general. One possible reason that risk management has been inconsistent is a failure of regulatory agencies to properly inform the managers in the same agencies. For example, the Office of

Drinking Water Standards of the Environmental Protection Agency, in a discussion of risks of organic hydrocarbons (1), omits any mention of chloroform, thereby withholding from the Administrator and from the public the instructive comparison with risks of trichloroethylene in our table 2 and on page 269 of our article.

We agree that no one makes choices solely on the basis of simple equations or point estimates and have said so in almost all of our writings, including the last paragraph of our article in *Science*. However, that is no excuse for not accurately determining the point estimate—and the uncertainty of that estimate—and for putting these numbers into perspective by comparison.

Public health officials, both in private and public, have in the last century emphasized acute effects that occur as a result of a short, high exposure. For these it is generally assumed that a low exposure means a risk close to zero. Risk assessors follow public demand in addressing the risk of cancer—a chronic effect arising from long exposure, often at lower levels. For these it is often assumed that there is linearity between response (probability of cancer) and dose. However, as we emphasized, the risk calculations for cancer can be a surrogate for other end points also.

Since for chronic effects risk is approximately dose times potency, dose information is vital. When it is available, a direct comparison such as, for example, for the radiation doses in our table 1, is less uncertain, and we find that people are helped by this. Again, however, we find that regulatory agencies and newspapers often omit this comparison, thereby failing to adequately inform the public of the risk and its meaning. This makes the risk assessment useless and any decision less well based than it need be.

We would also like to note, as kindly pointed out by Ernest V. Anderson, that in the discussion in our article of "Expression of risks" (p. 270, paragraph 2, line 24), an arithmetic error occurred: 0.0047% should have been 0.023%.

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**Erratum:** In the Research News article "Taking a closer look at AIDS virus relatives" by Jean L. Marx (19 June, p. 1523), Beatrice Hahn was incorrectly identified as a member of the Gallo-Wong-Staal group. Although Hahn collaborates with Gallo and Wong-Staal of the National Cancer Institute, she is in the Department of Medicine of the University of Alabama at Birmingham.