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discussion

Dynamic Aspects of Environmental Toxicology[1]

J. S. RUSTAGI.[2] THE paper by Professors Spear and Wei on "Dynamic Aspects of Environmental Toxicology" presents an interesting study for estimating the probability distribution of the maximum amount of mercury in the human system through simulation. There are many ways of obtaining the "body burden" of a trace substance in environmental health and many of the models proposed by various authors are deterministic. The present authors have proposed a stochastic model and have provided a simulation procedure for obtaining the probability distribution of the maximum amount of mercury retained by the human body. The assumptions made reflect their experience of the amount of mercury found in fish in California. It is assumed that there is no other source of ingestion of mercury except through fish, and the excretion is governed by the rule that only a constant fraction of the amount present in the body is excreted. The amount of mercury in fish is assumed to follow a lognormal distribution with certain known parameters as reflected in studies of fish in California. The amount of fish eaten is assumed to follow a normal probability distribution. The amount of mercury retained in the system is then calculated, allowing the amount excreted as a constant fraction of the amount present in the body. Assuming the experience of such a process over two years, the probability distribution of the maximum amount retained in the system is calculated.

In addition to challenging the assumption about the distribution, since no supporting data is provided in the paper, one wonders about the applicability of a single compartmental model for such an important trace metal, specially when it is known that certain percentage goes to other compartments in the body such as the brain. It is hoped that multicompartmental models will be studied by other researchers. It would be highly recommended if the model can be applied to data obtained on animal studies at least such as conducted by H. Cember [2] over the last decade. The adequacy of mathematical models can only be judged by their appropriate application to real life data.

[1]By R. C. Spear and E. Wei, published in the June, 1972, issue of the JOURNAL OF DYNAMIC SYSTEMS, MEASUREMENT AND CONTROL, Series G, Vol. 94, No. 2, p. 114.

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Authors' Closure

Dr. Rustagi raises two issues: The validity of assuming a single compartmental model for methylmercury and the adequacy of our model for "appropriate application to real life data."

In using a one compartment model for methylmercury we based our work on the investigations of Berglund and Berlin and of Aberg, et al. The assumption of a one compartmental model does not imply that methylmercury is not found in the brain but that the half-life in the brain is equal to that of the rest of the body. It is assumed that the various physiological compartments of the body are in internal equilibrium. Obviously different tissues in the body such as the brain, liver, and kidney may have different affinity constants for methylmercury. Our simplification was based on Aberg's experimental data indicating that the half-life of methylmercury in the head may exceed the total body value by 20 percent whereas the half-life in portions of the body below the waist may be 10–15 percent less than the total body figure. We felt that the magnitude of the difference in the half-lives should be regarded as falling within the range of experimental error since Aberg's data was obtained from three subjects only. It therefore appeared unrealistic to distinguish, as indices of toxicity, brain levels of methylmercury from total body levels of methylmercury except by the use of a proportionality constant as suggested by Berglund and Berlin.

Dr. Rustagi's second point, that is, the desirability of validating models by reference to animal data or, presumably, epidemiological studies on human populations, suggests that model development was our primary objective. This was not our intention and we attempted to distinguish our problem and approach from those of Cember and of Rustagi himself. We are proposing a method for unifying data from different sources into a mathematical format so that, even in the absence of scientifically precise information, quantitative predictions related to potential health effects can contribute to decision-making processes. As in the methylmercury example the objective will often be to estimate the extent of the problem. The accuracy of the predictions will be constrained by the available information and the results always open to criticism regarding the subjective judgments that will be necessary in model development.