

February 26, 1965

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Dear Bob:

First let me say that I am pleased to hear from you and to be assured thereby that the relationships that have existed between us for a goodly number of years are intact in both the personal and professional sense. I say this most sincerely, despite the fact that your query in this instance is not only double-barreled but multi-barreled.

The primary answer to the basic question of the human hazard that is involved in the distribution of lead on the surface of the earth from all sources lies in the physiological reaction or reactions of man to these environmental facts. The article in "Science" is only one of several in which this question is being raised. It will be raised more vigorously and pointedly in a publication which is scheduled (I think) for appearance in the Archives of Environmental Health by Claire Patterson, who has been talking widely (and wildly) on this subject for some months. (As a geophysicist or geochemist, or whatever he considers himself to be, he is, apparently a competent, studious and dedicated scientist, recently turned propagandist. As a biologist or physiologist, he has not even reached the level of a novice.)

The question, I repeat, is not what has happened to the surface of the earth, with respect to its lead content - although this is important in a variety of ways and for various reasons - but what has happened to men on that account. This is parallel to the question of the response of man to the lead distributed in the air while it is falling, rapidly or slowly, to the surface of the earth. As it happens the answers to these questions have been obtained to a very large extent, for the reason that we have been examining the facts in this connection, in a variety of ways, since 1923, when tetraethyllead first came into trial use in gasoline. The initial experiments were not very enlightening, but

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those of the past quarter of a century have adduced some highly useful and relevant data. The argument from these data, some of which have been presented and documented in the Harben Lectures for 1960, runs thus, (many of the data were obtained in the early 1930's, and have been substantiated by more precise methods of analysis in the years since 1940).

1. There are many minute sources whereby lead enters the human body. Some of these sources are natural, while many are artificial. These sources can be grouped according to their origin in soil, water, vegetation and animal life (that subsists on vegetation, water and other forms of animal life) and air.

2. In the period during which leaded gasoline has been on the market in the USA (the only country and population that have been investigated to such an extent as to supply valid data), there has been no increase in the gross intake and output of lead on the part of fairly large groups of persons in the (largely male) population of this country. (It is possible, since comparable data are not available for the early years up to the middle thirties, that there was some increase with the advent of the use of tetraethyllead. This is most unlikely, however, since there has been no further increase during the period of greatest increase in the use of tetraethyllead, i.e. since the middle thirties. Instead it appears that there has been some decrease in the intake of lead from all sources within the American population, during the period of most effective observation [1939 to the present]).

3. For the widely distributed lead in the present environment to be dangerous to man, it must be available (through the avenues of entrance) for absorption, and it must be in a form susceptible of absorption. Its presence on the surface of the earth is not sufficient. It must be taken up into the vegetation that is food for man and animals and, thence, also, into the tissues of animals that provide human food. It must, further, be in the water and other beverages used by animals and man. One must ask further, what happens (as to ordinary cleanliness and chemical contamination) to food from its origin in or on the soil, through the harvesting, processing, distribution, and preparation for eating (including cooking and contact with tableware)? If this sounds like undue emphasis on details of negligible importance, the opposite can be shown to be true. I am sure that the lead content of the food of Americans has been reduced from an earlier level, by the widespread attention that has been given to cleanliness, and to the composition of industrial processing equipment, cans, cooking utensils, and tableware. (I can give you verse, chapter and book on many details of these matters, and some have been published.) Not all of these sources have been brought under control, but the efforts of (for example) F.D.A. have borne fruit not only in control but in public and technical education.

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4. Now as to the lead in the air, there is no question whatever that lead occurred in the air of industrial and urban centers before the advent of leaded gasoline. No one knows how much because there were no satisfactory measurements. The best advice we have is to be found in the data of the measurements in Cincinnati in and around 1945, when the burden of soot and fly ash in Cincinnati in the air was high, and the lead content was, at least, twice as high as it is now, when the air is relatively free of soot and fly ash.

But whatever the facts may be concerning the sources of the lead in the air, the total quantity is of no significance hygienically, at present. (Incidentally, you are wrong in thinking that I estimated the lead from exhausts as contributing some 25 per cent of the lead in the air. The figure "25 per cent" related to the percentage of the lead in gasoline which, under the conditions of city driving, is likely to be discharged from the exhaust of the automobile in such form as to remain air-borne. This may or may not be exact, but it is probably not far from the truth.) Of that which occurs generally in the atmosphere, our observations have indicated that somewhat less than 20 per cent is retained in the lung. Specifically, when men are subjected to the inhalation of air containing lead sesquioxide, in minute subdivision (less than 0.2 microns in diameter), in the concentration of about 10 micrograms per cubic meter, they retain somewhat less than 20 per cent in the respiratory apparatus, the remainder being exhaled. It happens, therefore, that the quantity of lead in the general atmosphere of cities is too small to make much of a contribution to the total quantity of lead which is absorbed from day to day from food and beverages, and thus we have been unable to find statistically valid differences between the levels of concentration of lead in the blood and urine of persons who live in Los Angeles (where the average concentration of lead in the air is somewhat more than 2 micrograms per cubic meter), and those of corresponding groups of people in Cincinnati (where the concentration in air is somewhat more than 1 microgram per cubic meter).

As to the significance of the deposition of lead on the surface of the earth, I can provide very little useful information, beyond the fact that it appears that much of this has been carried off in rainfall, and that much of it reaches the sea, ultimately. If this is true, it is to be expected, since most of the lead discharged from automobiles is soluble, in the form in which it is deposited. It would also be washed away from city streets mechanically, thus reaching streams, and being borne as solute and suspended material until it is converted to relatively insoluble compounds and (in relatively quiet water) precipitated. I have no doubt that the sediment in many streams and lakes, and in oceans, contains lead in concentrations higher than those in the water and in the adjacent soils.

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Certainly, there is no doubt that the vegetation along highways in this country and Canada (and doubtless elsewhere) has more lead (mainly on its surface, I should suppose) on it than that found thereon (or therein) some distance away, as an expression of the deposition of one-time, air-borne lead from automobiles. Up to the present time, no evidence has been found that forage crops from fields affected in this manner, have been responsible for any difficulty among grazing or stable-fed herds. (On the other hand, cattle have been poisoned and some have been poisoned fatally by the prolonged use of forage crops contaminated by lead from smelters and other plants that have discharged large quantities of lead in less soluble form. Here again the matter is one of quantity, and of a much wider area over which a freely divided, and therefore more readily air-borne form of lead compound, is distributed.

There are here questions for further investigation. Part of what I have said above is speculative or based on fragmentary data. The ultimate fate of the minerals that are obtained from the bowels of the earth and scattered about has never been determined in a satisfactory manner. The facts concerning the migration of the minerals on the surface of the earth, and those at greater depth, and the relationship of these migrations through the centuries and eons, to the physiology of plant and animal life on the earth and its waters, could be a fascinating study for many lifetimes, and still leave many mysteries to be elucidated. The geologists have learned many things and have inferred many others. Some members of that professional group appear to have been unduly impressed with some of their fairly recent successes, and have come to the apparent conclusion that their methodological efforts have rendered all other methods obsolete, and all other one-time accepted facts, myths. I think they are due for a rude awakening when they are confronted with some of the complexities of biologic reaction and adaptation. A little knowledge is a dangerous thing, especially in association with an extravagant appraisal of the value of certain recent methods of investigation. New methods of investigation may open up a new universe of phenomena, but they may, and often have, merely enhanced precision in the first or second decimal place.

With kindest regards,

Sincerely yours,

Robert A. Kehoe, M.D.

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