The subject of "normal lead" has been extensively investigated by Kehoe and his associates (1933,1939),

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who have found that the normal American adult excretes lead at the rate of 0.25 to 0.40 mgm. per day. Most of this lead is present in the feces, the urinary output amounting only to 0.02 to 0.10 mgm. per day, (0.02 to 0.06 mgm. per liter). The normal concentration of lead in the feces is from 0.03 to 0.11 mgm. per gram of fecal ash. Analysis of duplicate 24 hour samples of the food of a series of normal individuals revealed that 0.22 to 0.35 mgm. of lead per day was obtained from this source. A portion of the lead content of the food was found to be of natural origin, but additional quantities were derived from a variety of artificial sources. Those foods which were found most commonly above an average lead content were, in order of increasing importance, bread-stuffs, meats, processed meats, ice cream, candy, leafy green vegetables, and certain fruits. ~~Subsequently (1939)~~ these investigators in essential agreement with Willoughby and Wilkins (1938)

Willoughby, C.E. and Wilkins, F. S. Jour. Biol. Chem. 124: 639,(1938)

and Kaplan and McDonald (1938) obtained a mean value of approximately 0.030 mgm. per 100 grams of the whole blood of normal individuals and showed that their earlier results owed their variability and their higher and less stabile mean value (1935) to certain sources of contamination in the collection of blood samples. They also showed (1938, 1939) that the blood of Mexican Indians, living on

contained lead to the mean extent of 0.02 mgm. per 100 grams.

The identification of lead in the blood, urine, and feces, therefore, is not indicative of lead poisoning. However, when exposure to lead has been excessive, and the symptoms of poisoning occur, normal values are greatly exceeded. Kehoe and his associates (1933,1939) have studied groups of workmen under a variety of conditions of occupational lead exposure. Depending upon the occupation, they found that the mean daily fecal lead output of groups of men varied from 0.47 to 7.60 mgm., (0.09 to 0.57 mgm. per gram of fecal ash). The mean lead concentration in the urine of the corresponding groups ranged from 0.05 to 0.34 mgm. per liter. Cases of lead poisoning were found among certain groups of these workmen; and from the correlation of the analytical with the clinical findings over considerable periods of time, Kehoe and his collabrators drew the following pertinent and practical conclusions. Occupational lead exposure is safe if it does not give a mean lead output of more than 0.60 mgm. per day in the feces or a mean urinary concentration above 0.10 mgm. per liter. Poisoning may be expected to occur under conditions in which lead occurs in the feces of workmen in excess of a mean level of 1.1 mgm. per day, and in which the mean urinary lead concentration exceeds 0.15 mgm. per liter. The higher the values go above these levels, the greater will be the frequency of occurrence and the severity of lead poisoning among the workmen. The threshold concentration of approximately 0.10 mgm. of lead per liter in the urine, corresponds generally, under conditions of maintained lead exposure, to a blood concentration of 0.06 to 0.07 mgm. In acute lead intoxication, resulting from very severe exposure, the blood concentration may rise as high as 0.30 mgm. per 100 grams

of whole blood, but under more usual conditions of hazardous exposure, it is found between 0.05 and 0.15 mgm. per 100 grams of whole blood. Kaplan and MacDonald found lead levels in the blood ranging from 0.6 to 0.10 mgm. per 100 cc in their cases of lead poisoning. No doubt in a number of their cases, some opportunity had been given for a lowering of the blood concentrations below those present at the time of their exposure. (This is doubtless true because of the time elapsing between the onset of illness and the time of taking the samples. Our own results on hospital and industrial compensation cases, seen some days or weeks after the cessation of exposure, give values considerably lower than those found among workers at the onset of their illness. RAK.)

Additional comments on certain phases of this matter.

1. The expression "fecal output" has been used instead of "fecal excretion" because most of the alimentary lead is not excreted in the physiologic sense but merely traverses the tract unabsorbed.

2. Reference is made to "the daily intake by ingestion and from the upper respiratory tract" because this lead in the feces is a rough but practical measure of the intake by inhalation, which, of course, is much more important than that swallowed. In the following paragraph on the toxic level of industrial lead exposure, the significance of the fecal lead output is expressed on this basis. There is no reference here, therefore, to the threshold of toxicity of purely ingested lead, since the latter is known to be of a very different order of magnitude. For this reason, I have inserted the word "occupational" before "lead exposure" in the sentence beginning "Lead exposure is safe if " . . . etc".

I have also changed the following sentence so that it refers specifically to "workmen".

3. The quoted paragraph presents my present opinion quite accurately.