

January 20, 1954

Mr. James L. Hart
Chemical Engineer
National Zinc Company, Inc.
Bartlesville, Oklahoma

Dear Mr. Hart:

I regret very much indeed that I have been compelled to delay so long in replying to your letter of December 3. I have been submerged by a series of matters that accumulated while I was out of the country, and only the most urgent items of correspondence could be attended to. In the belief that the available data on cadmium would not permit me to give you information that would contribute significantly to the safety of your people, and that, in fact, they are not, at present, as a group, being subjected to serious and insidious risks due to exposure to cadmium, I have felt it necessary to deal with more urgent matters at hand. On the other hand, in those instances in which the results on an individual, with reference to lead, justified my advising precautionary measures, I have so indicated on the analytical report concerned. I shall continue in the future to do this. Our experience enables us to give specific advice at times, and I always do so when it is indicated, since I know that your people cannot be expected to interpret the results with adequate precision.

I shall answer your questions in sequence, so far as I can. They cannot be answered satisfactorily by simple statements, so that discussion is required.

1. The variation in the results obtained on the blood of individuals at different times, must first be judged as to whether they are within the limits of error of the methods. The average error of any of the results on lead reported to you is about ± 0.01 mg. This means that if one result errs on the high side by 0.01, while a second on the same blood errs equally on the low side, differences of 0.02 mg. per 100 grams can appear by chance alone. For this reason, we carry out parallel analyses in most instances and take the average. It is inconvenient to do this in the work we are doing for your people, because of the necessity of analyzing for both lead and cadmium. You will note, by this criterion, that the differences in the results referred to are not great, being only dubiously beyond the range of analytical variation.

A significant matter of differentiation arises, however, in the case of

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██████████ whose first result was 0.085 mg. per 100 grams. It is evident from what I have said that this may have been as low as 0.075 or perhaps even 0.07; or it might have been 0.095. The situation here is troublesome because it is just at the critical level of concentration and, therefore, danger is involved. Reference here is troublesome because it is just at the critical level of

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When conditions of occupational exposure vary significantly from day to day, the levels of lead concentration in both blood and urine can change appreciably within a few days. In each case that you have called attention to in your appended data, there was a decrease in the blood levels in two months, more or less. As I have indicated previously, this may be mostly analytical variation, but from the aspect of probability, as well as physiology, it is highly unlikely that this uniformity could have come about from any other factor than a decrease in the severity or the duration of the exposure of these individual workmen, or from a decrease in both of these factors simultaneously. The change, to be sure, is not great, but it clearly indicates a trend, which relates not necessarily to the environment alone, but to the behavior of the men, with respect to their absorption of lead. If I had additional analytical results that would average out the factor of analytical error, I would say, unequivocally, that there was a decrease in the absorption of lead on the part of these men. *

A high result - that is a result of 0.08 or more mg. per 100 grams - must always be taken seriously. If there is doubt, in that the result is too near the borderline of 0.08 and, therefore, is within the range in which the

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analytical error is significant, the result should be checked at the earliest possible time, so as to know what must be done. No man at this level should be left at work under unchanged conditions of exposure, since he may quickly develop a temporarily disabling illness. Judgment can be exercised here, in that if the exposure has been temporarily great under highly unusual circumstances, the high concentration will subside quickly and the risk will be over, for that time.

Whenever high results in the blood occur unaccountably in a scattered manner in a group working at the same kind of job, the exposure is erratic, inadequately controlled, and the men as a group are in danger.

Analytical results, obtained properly, are for the purpose of bringing the exposure under control, in either one of two ways:

(a) By proper engineering of the job and the environment. This, of course, is the only satisfactory way.

(b) By enabling a physician to advise the removal of unduly exposed men from work involving exposure, until excretion takes care of the excess absorbed. Legally it is mandatory, for all practical purposes, to follow such advice, since otherwise the development of illness in an employee is a matter of personal responsibility on the part of the appropriate representative of the employer, which, in most of our States, renders him liable to prosecution for criminal negligence. It is necessary, therefore, that such medical advice be soundly founded in fact and judgment, but it is also necessary that it be followed.

In the terms of the foregoing discussion, then, the answers to your questions are:

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(a) The blood level can change quick- /within a few days, in response to significant changes in the severity of the exposure, or in response to the continuation of a severe exposure. Under stable conditions of exposure the blood level moves up gradually over a period of months to a point which is indicative of the severity of exposure, and then tends to remain fairly constant.

(b) Your conclusion concerning the status of a particular man should be based on the trend shown by a series of results, but when the critical level of danger has been reached, action should follow promptly.

The interpretation of the overall situation of an occupational group of men must depend on the study of all of the data available on all of them.

(c) In general, to follow the trend of an occupational situation (whether it

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is improving, remaining stable or getting worse), it is necessary to repeat the analyses on the group from time to time. The same is true in the case of the individual man. In both instances the periodicity of the analytical survey should depend on the extent of the danger - i. e. on the known or apparent severity of the exposure - , and this can only be determined after a period of observations.

(d) Any man whose results are in the dangerous range should be removed from exposure, or his exposure should be controlled and diminished, immediately. If there is doubt as to his status, the analyses should be repeated at the earliest possible time, in order to resolve the doubt.

Certain of your men are exposed to hazardous conditions, with respect to lead. How general this is can be determined only after a careful study of all of the data on men whose work has been continuous and well documented with respect to type, job and area. In this connection the results of air analyses will not correlate too well with those on the blood and urine, until and unless the conditions of exposure throughout the plant are well stabilized so as not to be significantly variable from time to time. In any case, there is no doubt about the existence of hazardous exposure to lead, and improvements in plant operations should be made.

2. With reference to the cadmium problem, I can give you little sound advice at present. (a) I can say that the analytical procedures have a high degree of precision - approximately that of the procedures for lead - and that the variability observed is due only in minor part to analytical variation. There is not enough information on physiological variation to enable us to view the significance of the data on this score.

3. (a) We have no more adequate data on any other occupational situation relating to cadmium than we do on yours, and so I cannot advise you properly in response to your questions. We shall have to wait and see. Presumably any thing that is done generally to decrease the exposure to lead will influence the associated exposure to cadmium.

lead

(b) Under present conditions of hazardous/exposure, you should repeat the analyses on your men at an early date so as to establish more fully the extent and severity of the hazard.

(c) The working conditions, with respect to lead, need improvement.

(d) You are likely, under present conditions, to have cases of lead intoxication, at least mild cases. The procedure here is one for Doctor

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Aldredge to deal with, and the less anyone else has to do with it the better. Certainly the analytical procedures and results in the study of suspected cases is strictly confidential information which should not under any circumstances be available outside the medical office. I direct my remarks on this subject to him, therefore.

First, the man who complains of symptoms should be examined carefully and a differential diagnosis should be arrived at, if this is at all possible, by clinical means. There is no possible substitute for this. A complete record (confidential) of the examination should be kept, and the procedure from there on should be recorded in detail. If there is justification for so doing, the doctor should obtain samples (duplicate) of blood, and a spot sample of urine, under his own supervision, forwarding them to us with a summary, at least, of the clinical record, and a complete statement of the employment record, noting especially the length of employment under conditions of exposure, the last day on which exposure occurred, and any other pertinent matters relating to the employment or to the clinical problems. We shall then be able to give sound advice as to the situation and its further investigation or handling.

(c) The extraordinarily high results obtained on a few samples of urine are probably the result of contamination of the samples. Such contamination occurs from time to time and is one of the dangers of relying on analyses of urine alone. We are able to appraise the significance of these with little doubt, in the case of lead, but we know too little about the variability of the excretion of cadmium to arrive at more than tentative conclusions based on statistical probability.

You will gather that these are many matters to be considered and dealt with in a situation of the type with which we are presented here. You will see also why I delayed any attempt to reply until I had disposed of the somewhat more urgent claims on my time. This rather formidable letter could be extended to many more pages, if there were profit in doing so. On the whole, however, I have attempted to deal with the matters of real significance, and to relegate unprofitable speculation and discussion to the future, when more facts should be available.

Cordially yours,

Robert A. Kehoe, M. D.

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C.C.: Dr. William M. Aldredge

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* The reduction of this exposure and absorption of a man or a group may be accomplished to some unpredictable degree by securing the careful use of respirators, and this may have been the answer in these or other instances.

If safety depends on such measures in more than temporary situations, it is highly insecure. Dependence should never be put in such measures in continuing situations. The only suitable remedy is to correct the matter at its source.

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