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SYMPOSIUM ON OCCUPATIONAL HEALTH EXPERIENCE AND PRACTICES IN THE URANIUM INDUSTRY

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HEALTH AND SAFETY LABORATORY
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Medical Findings Summary

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The main point brought out at this symposium, from a medical standpoint, is that uranium is a toxic material to which many people have been exposed over a fairly long period of time, and yet, according to one viewpoint, we have yet to see the first case of injury from normal uranium. There is a fringe consideration here, namely, that of abnormal kidney function; there are perhaps a few cases of albuminuria, however temporary, that could be ascribed to uranium toxicity. This is really quite a striking observation, particularly in view of the fact that in the early days exposures were many times what we consider permissible today, not twice or ten times but up to 100 to 200 times the maximum permissible air-borne concentration. In spite of this, there has been no great wave of uranium illness.

The other viewpoint is that uranium is a highly toxic material, and this has been borne out by laboratory experiments; however, these were carried out with laboratory animals, and one wonders whether there isn't some remarkable difference between humans and laboratory animals in regard to uranium toxicity.

We have had discussions on tissue analyses from autopsy material, presented by Dr. Quigley and Dr. Butterworth, and these showed no definite injury that could be ascribed to uranium, and, in addition, showed smaller concentrations of uranium in the tissues than expected.

The Rochester experiments are quite significant, and the final outcome of the 5-year insoluble uranium inhalation study will be of great interest. It is quite striking, I think, that no definite histopathologic changes have been seen in the animals examined so far, in spite of the fact that concentrations of uranium in pulmonary lymph nodes of up to 15% have been found.

DISCUSSION

CHAPMAN: I have two questions. There are at least three groups of people at this symposium, those from service organizations (like myself), the research group, and some who are seeking information; and I am sure they are all confused. I consider that air sampling and urine sampling are both necessary, but the results cannot be carried out to many significant figures. Maybe it is only necessary to determine whether milligrams or micrograms are involved; or maybe one order of magnitude is not enough.

Several plants, such as Harshaw, Linde, and others (Mallinckrodt is the only one remaining), had some experience in the old days when some people were probably overexposed, and we need some clinical history on these people.

I think the thing that we have to determine is the point that has been raised several times, and about which Dr. Neuman said that we must be patient. I admire his courage, but my first question still is: Is there any way that uranium can injure a man other than his dropping a 100-lb pellet on his foot?

The second question involves beta exposure: Is 2.3-Mev beta penetrating radiation? How do we interpret an employee's exposure to uranium? Can we write it down on a piece of paper and give it to the man, so that he can give it to his next employer for the latter to calculate how much exposure he has left in life according to the recent formula? What is the maximum permissible body burden? And what about skin dose: can it be disregarded or should it be included?

The new exposure levels are based on genetic effects. Can the 2.3-Mev beta reach the gonads? I consider it academic whether we measure air exposure or urine exposure when the thing we are interested in is the clinical picture. We have been quibbling over numbers that to the practical man don't mean very much. What we are really interested in is whether money should be spent for ventilation or for shields or for a urinalysis program. Some of us have to answer to stockholders, some to taxpayers, and some to unions. This is a serious practical problem which the research

people do not consider when they are quibbling over these numbers out to three or four significant figures. The International Committee on Radiation Protection, which does not have to answer to stockholders, unions, or taxpayers, but only to a group like this, has set up these numbers, and they require practical interpretation.

BERNARD: Some of us believe that the damage is due to the amount of uranium in the body; that is why we argue about how to estimate the amount of uranium in the body.

MASON, M.: I think the question concerns what the damage is.

NEUMAN: I have been accused of being courageous; I think it would be courageous to say the MPL is too low; it is not courageous to defend it. As I understand the MPL, it is the maximum exposure that is considered not to harm anyone, further reduced by a factor of 10 because of our great uncertainties. Therefore, an exposure below the MPL should not injure anyone, particularly in a group as small as 4000. The MPL for the population as a whole is reduced by another factor of 10 because of the variations in the reactions of the individuals in so large a group. At this level there should be no injury to anyone in the population as a whole. I cannot understand why everyone is surprised that people are not showing bad effects from uranium exposure, since that is what we have been trying to prevent.

Also, do you want to say to your stockholders that you are running an economical plant because you are not spending money for these precautions, and are consequently injuring so many individuals each day – or each month or each year? Is that proof of an economical operation? This decision between human lives and damage, and dollars and cents, is difficult. I, for one, will help you defend your precautionary actions against any stockholder who chooses to object.

QUESTION: It seems to me that several types of injury have been mentioned. Dr. Snyder spoke of kidney injury, and it seemed that the injurious concentration in terms of μg U/g kidney for different species might be the same, but that perhaps some species have to take in much more uranium to get that concentration in the kidneys. Maybe this depends on the solubility of the uranium. This brings up the practical question of whether one MAC can be set for both soluble and insoluble uranium.

What were the symptoms in the individuals on whom information was collected? It has been said that there were no symptoms found in certain individuals exposed under certain conditions in the past; but symptoms have been found under certain experimental laboratory conditions. Is it possible that these laboratory symptoms might be found under actual conditions?

I would particularly like a résumé of the type of damage found in the individuals in the Boston hospital who were intentionally exposed to uranium. Since these were brain cancer patients, certainly not in good health, what conclusions can be drawn from such cases?

SNYDER: I am not a medical man, and I cannot make a definitive evaluation of any of these medical data; rather, I am seeking guidance in interpreting them. The data that I presented, except for a very few of the numbers at the end, were animal data. I am not competent to tell you exactly what the symptoms were. I tried to pick out exposure levels that were most representative. There were higher levels of exposure where severe effects were found. There were levels lower than those I discussed, where it was very difficult to decide that there was no evidence of damage. At the intermediate levels, damage was fractional. I did this realizing my incompetence to assess the medical data and in the hope of getting competent people to do so in order to give us a more precise estimate of the various factors that enter into a determination of the permissible level. These factors are numerous, and interpreting them will not be easy. We need to know at what level of kidney damage we are willing to set the permissible level, or by what factor we should stay below the level of any kidney damage.

At this symposium two entirely different kinds of damage have been discussed. On the one hand, no worker has been killed or had symptoms so severe as to be apparent on casual inspection. I feel that an exposure level is too high if it is based on the absence of severe symptoms or the appearance only sporadically of any symptoms; to consider such a level safe is to take a considerable and unwarranted risk. This is my personal opinion, and it is true that there are other risks of greater magnitude in everyday living, but this is a question of values outside the present discussion. But I cannot be convinced, without detailed follow-up of the individuals exposed at high levels, that no severe injury will ever be found, and its absence up to

now is not a valid reason for considering such levels permissible. I think that would be a dangerous attitude, even though I cannot evaluate the expectation of such symptoms appearing. On the other hand, in the laboratory experiments detailed examinations are made of tissues on quite a different level, and an entirely different sort of damage is being studied.

Someone must decide what degree of damage we are really trying to prevent, the very slight appearance of a kidney defect or severe damage that is clinically quite apparent. The underlying philosophy of the NCRP and the ICRP tends towards the former. These groups try to set limits below the level at which any detectable damage will occur. The exact determination of this level is a matter for careful consideration by medical people. The same remarks apply to practically every other parameter with which we are concerned. More precise information should be obtained about the effects of such things as particle size, chemical form, manner of exposure, and dose rate. The data indicate that the body burden is not directly proportional to the exposure level. Further study is needed before a maximum permissible level can be definitively determined.

As it stands now, in view of the many uncertainties, I think that Mr. Bailey's philosophy is that the maximum permissible level is set at a level where we hope that no severe effects will turn up later to embarrass us. The level cannot be given in precise numerical terms. On the other hand, many of the questions about the specific parameters can be answered much more precisely than they have been by both experimenters and practical men. Then we will be in a position to say what limit we are willing to accept.

A question was also raised about the Boston patients. I have been told that every one of them showed severe kidney damage, though I do not know the exact details. Of course they were brain tumor patients, and this must be taken into account in interpreting the data. Most of the human data will be subject to such uncertainties, probably as long as we operate.

EISENBUD: The people who have to discuss economics with stockholders are not callous, and they do not want to subject the industrial workers to any risk. We are not challenging the maximum permissible concentration, *per se*, but I think it would be presumptuous, after 15 years, not to permit a re-examination of the assumptions that went into the calculations of the maximum permissible dose. The figure used to govern the maximum permissible air concentration is based on experiments with lower animals, and is based on assumptions concerning the amount of inhaled dust deposited in the alveolar tissues and the rate at which it is cleared from these tissues. These assumptions should be examined in the light of the new data. I think the deposition of dust in the lungs is lower in the experimental animals, and there is evidence that the lung clearance is somewhat more rapid than was assumed. The fact that autopsies on men exposed to uranium show only a very small fraction (perhaps $<1\%$) of the amount which calculation says should be present in the tissues necessitates a re-examination of the calculations and the factors introduced many years ago, which have not been changed on the basis of data accumulated since.

At present there are not sufficient human data for us to be able to say that, because some men exposed to 78,000 $\mu g/m^3$ did not get sick, the maximum permissible dose can be raised by a factor of 100. No one is saying that. But, considering that the present limit is 50 $\mu g/m^3$, the accumulation of new evidence changing some of the factors that went into the calculations furnishes a good reason for these calculations to be re-examined.

HOLADAY: Our primary mission is to protect the workers, but, if by so doing we make a process inoperable, that is no solution to the problem. I agree with Mr. Eisenbud that the question concerns not so much the level of the MPC as its validity. On what assumptions were these levels based? And how do they stand up with experience? As I pointed out earlier, the only way to answer some of these questions is by an epidemiological study of people exposed 10 to 15 years ago. This is a long time in the history of a toxic exposure, and, considering that the exposure levels ranged from fairly low to rather high, these few hundred people should show us something. I think such a study is necessary.

As Mr. Eisenbud said, these permissible levels have been set on the basis of the calculated radiation dose to an organ, e. g., the lung. There is probably some correlation between the calculated and the true dose, but I do not know what it is. There is certainly not an exact equivalence because of the various assumptions used. Therefore, the difference between levels of, e.g., 50 $\mu g/m^3$ and 250 $\mu g/m^3$ is for all practical purposes insignifi-

cant considering the various errors in the assumptions. People experienced in this field are aware of this low degree of exactitude. It is the inexperienced person, following the procedure of a factory inspector, who says that 55 or 75 $\mu g/m^3$ is bad, not realizing that it is no better and no worse than a figure of 40 $\mu g/m^3$, or for that matter 100, as far as estimating the true situation is concerned.

I would like to see the threshold level for uranium treated in the same way as threshold levels for other toxic materials, as a guide to an estimation of the situation with other factors also taken into account. An understanding of the fuzziness of the figure will allow it to be properly used for the present, until such time as epidemiological data become available. I think there is good reason to believe that no one will be hurt by the use of the present MPC as a standard threshold level, rather than as a fixed "'good" or "bad" reference point.