ON THE VALUE OF MEASURING MERCURY AND CADMIUM CONCENTRATIONS IN URINE

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In connection with " maximum allowable concentrations in biological materials ", I should like to express some views on the value of measuring mercury and cadmium concentrations in urine. These remarks are based on findings in human subjects and in experimental animals.

Mercury which is absorbed into the body is largely excreted in the urine. From this aspect, therefore, determination of the urinary output of mercury might be assumed to be a useful measure of the exposure to mercury. Many investigations have, in fact, demonstrated a correlation between the amount of mercury in the urine and the exposure to mercury, although this relationship has not yet been fully elucidated from the quantitative viewpoint. I should like in this connection to draw attention to some sources of error which are associated with assessment of exposure based on urine analysis.

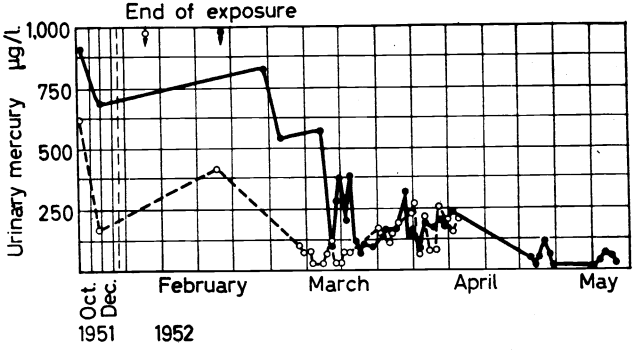

Figure 1. Urinary excretion of mercury in two workmen with mercury poisoning. The arrows show when exposure ceased

Figures 1 and *2* show the variations in the urinary excretion of mercury in two cases of mercury poisoning. It is seen that the output of mercury can vary widely from day to day and month to month, and also at different times of the same day, but that these fluctuations are not associated with variations in the exposure. Hence it is obvious that, if urinary values are to have any relevance, variations with time must be carefully considered. It is also necessary, however, to know when the essential exposure occurred. A given concentration of mercury in the urine may in one case, reflect contemporary exposure, but, in another case, as I have exemplified here, may be attributable to exposure months previously.

That different norms must be used for different compounds of the same substance may seem self-evident. As this distinction is not always observed, however, I will cite an example of its importance. *Figure 3* shows the content

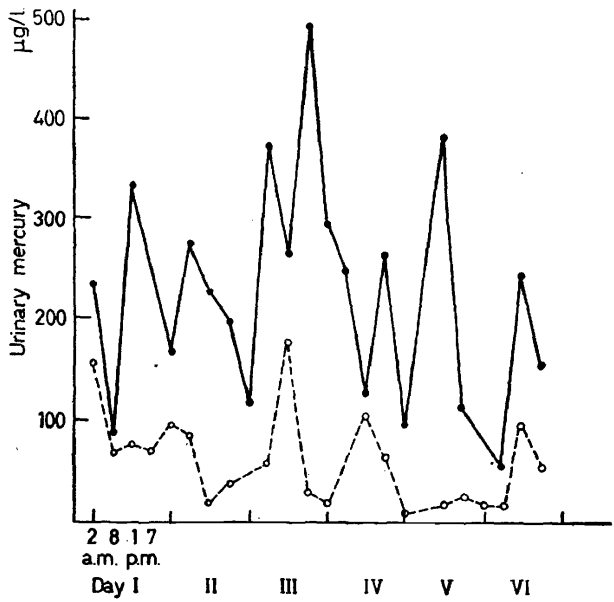

Figure 2. Variations within the 24-hour excretion of mercury in two workmen with mercury poisoning. Exposure to mercury had ceased one to two months previously

of mercury in the urine from a group of rats exposed to mercuric chloride and from another group exposed to the equivalent amount of methyl mercury dicyandiamide. It is clear that the excretion of mercury after administra-

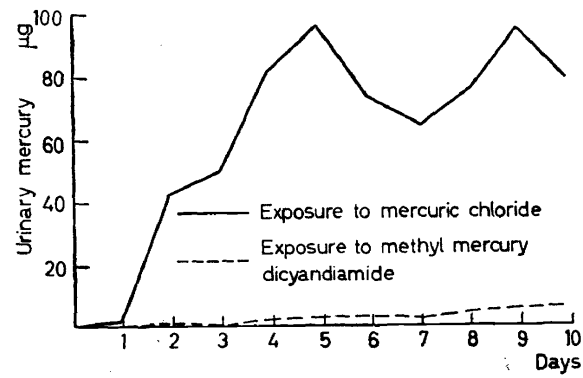

Figure 3. Excretion of mercury in the urine

tion of the organic mercury compound was insignificant compared with that in the rats injected with mercuric chloride.

Also, as regards cadmium poisoning, it would be desirable to fix for a biological material a maximum allowable concentration of the toxic substance. Cadmium is to some extent eliminated in the urine, but animal experiments and post-mortem analyses of organs from human subjects with cadmium poisoning have shown that much of the metal accumulates in the body,

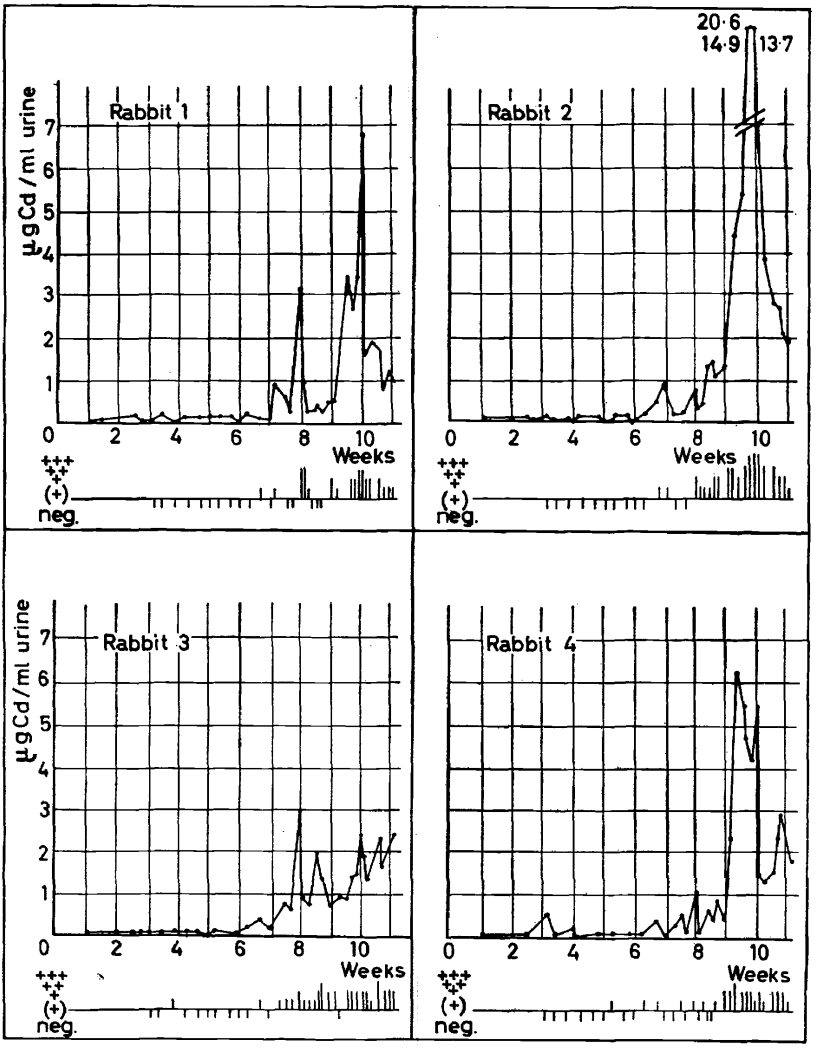

Figure 4. Content of cadmium and of protein in rabbit urine during daily exposure to cadmium

especially in the kidneys. Animal experiments further showed (*Figure* 4) that, despite daily exposure to fairly high concentrations of cadmium, almost none is present in the urine during the weeks immediately after exposure. Excretion begins gradually after a certain degree of damage has occurred, or, possibly, after a certain threshold value has been reached.

The content of cadmium in the urine then increases sharply at the same time as toxic signs (proteinuria) appear. Since this increased urinary output of cadmium obviously is by no means indicative of a corresponding increase in the degreeof exposure, urine analysis has very limited value as a yardstick for measuring exposure. Analysis of blood samples would seem to be more useful in this respect, as the concentration of cadmium in the blood of animals, at any rate for a fairly long time, increased proportionately with the duration of exposure.

One may wonder, concerning substances which are retained for a long time in the body, if it would not be most rational to expose experimental animals to these substances at the places in which they are used and then, at suitable intervals, to analyse the " critical " organs, possible also the urine and faeces, for content of the toxic agents. Such a procedure would seem to offer the only reliable measurement of the total exposure and of the dose of the substance which actually is integrated in the body.