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September 5th, 1944

Mark C. Baca 12/13/79
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SEP 27 1979

Dr. L. I. Schiff
Physics Dept.
University of Pennsylvania
Philadelphia, Pennsylvania

Dear Dr. Schiff:

I am sending you the information that we discussed when you were here. At the risk of boring you, I will again go into considerable detail as to just what the problem is.

We try to diagnose how much plutonium an individual has in his body by analyzing his urine for alpha activity. The human excretes about 0.01 per cent of the total amount of plutonium in the body every 24 hours. The tolerance value for internal contamination is 1 microgram of plutonium = 70,000 alpha counts per minute. One-hundredth of one per cent of 70,000 = 7 c/m. We are forced then to detect of the order of 7 alpha counts per minute in a 24-hour urine sample.

Unfortunately, persons having never worked with radioactive materials seem to show a slight amount of alpha activity in a 24-hour urine sample. This activity we call a blank and it is subtracted from the result obtained on the urine of an exposed worker. It is also necessary to correct each result for the background of the alpha counter. The value that we use as an indication of the plutonium in the body is the net count obtained from the sample; i.e.:

Net c/m = total c/m in sample - background c/m - blank value in c/m

The following is a detailed discussion of each value in the above expression, how it is determined, how it is used, and with what accuracy it has been determined.

(1) Net Counts per minute -- The net c/m ÷ (0.0001 x 70,000) = micrograms of Pu in the body. To test the accuracy of the method, known amounts of Pu were added to 24-hour samples of urine and the samples carried through the entire recovery process. (The total c/m in the sample was determined by counting for a period of at least 60 minutes.) The net c/m was obtained by subtracting a counter background and the average blank value of 0.67 c/m discussed in (4) from the total counts obtained from the sample. In 42 determinations the mean recovery (as indicated by the net c/m) was 82.4 ± 8.3%. These data are given in Table 1 in order that you may see how the values were calculated.

(2) Total c/m -- The total counts per minute in any given sample was determined by counting for a period of at least 60 minutes. Frequently the counting time was much longer. For statistical evaluation of the data

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let us use the minimum counting time of 60 minutes.

(3) Background of the Counter (c/m) -- The backgrounds of the alpha counters used for these determinations were determined by letting the counters operate all night with no sample in them. Once or twice during the day 60 minute backgrounds were taken just to make sure the backgrounds during the day were essentially the same as during the night. During the past 1½ years 654 background determinations were made. The average of the 654 determinations was 0.47 ± 0.17 c/m; i.e.; the over-all mean was 0.47 c/m and the mean deviation of all results from the mean was 0.17 c/m. The average counting time for the 654 determinations was 687 minutes.

(4) Blank Value in c/m -- Apparently persons never having been exposed to Pu excrete a small amount of activity in a 24-hour urine sample. Another explanation may be that we cannot completely avoid picking up a small amount of contamination during the processing of a large urine sample. Regardless of which is correct it is necessary to subtract this blank value from the total c/m in calculating the exposure of personnel to Pu. The value of the blank has been established as follows:

One hundred fifty urine samples were collected from persons who had never worked with radioactive materials. These samples were analyzed according to the procedure for Pu analysis. The results are given in Table 2. The mean value for the 150 blank determinations was 0.67 ± 0.38 c/m; i.e.; the mean blank was 0.67 c/m and the mean deviation of all results from the mean was 0.38 c/m. The average counting time for the blank determinations was 60 minutes. The blank value has had a counter background subtracted from it. It is a net result.

Blank c/m = Total c/m found in a 24-hour sample of urine from an unexposed person minus the background of the counter determined just before the total count was made.

I will now try to summarize all that I have said and to state the problem in a few words:

Net c/m in urine of an exposed person = total c/m found in sample minus the background of the counter minus the mean value of the blank.

Counting time = 60 minutes
Mean background of counter = 0.47 ± 0.17 c/m
Mean blank value = 0.67 ± 0.38 c/m (The mean blank has had a counter background subtracted from it).

I would like to have you:

(1) Tell me if urine values of 1-20 c/m determined in this way and under these circumstances have any statistical significance.

(2) Derive an expression for showing the probable error and the statistical significance of any particular urine result that we may obtain under these circumstances.

If you will send me your derivation of the expression and the results

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of your calculations, I will write it into my report of the method (provided of course you find the method statistically sound) and list you as a co-author. I am anxious to have your results. Let me know if you need any additional information.

Sincerely yours,

Wright Langham

WL/ars
Enclosures

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