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HEALTH CANCER RESEARCH PROGRAM

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March 18, 1944

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A. SUMMARY OF OVER-ALL PROJECT HEALTH ACTIVITIES

Robert S. Stone, M.D.
Associate Project Director for Health

Personnel Studies

Six applicants of Chicago and eleven at Clinton were rejected on medical grounds.

The hands of some workers in Chicago, Clinton, Berkeley and St. Louis have been examined and no changes definitely due to radiations have been found.

Blood studies have uncovered two individuals at Chicago whose changes might be due to over-exposure to radiation. Two individuals at St. Louis who have had persistent low white blood levels have had some over-exposures. Two workers at Clinton have shown a lowering of count with no over-exposure.

A dispensary service for the Metallurgical Laboratories' employees has not yet been fully established because of our inability to procure a doctor. It is expected that one will arrive during March. The Clinton Laboratory dispensary service continues to operate satisfactorily. Four sub-major injuries were cured for: 2 HF burns, 2 finger fractures.

Radiation Hazards

Pocket Ionization Chambers continue to yield valuable information. The chambers in use are not perfect (what instruments are!) but they are sufficiently accurate in a high percent of instances. We ask the cooperation of all offices in investigating high readings since this is the sure way of checking them. Under usual conditions low readings are common.

Hand and glove contamination studies are well under way at Clinton and are getting started at Chicago. They have shown many instances of serious contamination that has been radically reduced by proper washing. No satisfactory substitute for soap and water has been found.

Tongue contamination from pipetting an active solution of radio-zirconium has occurred at Clinton. If mouth suction for pipettes continues to be used someone will experience a severe case of radio-active poisoning.

Contamination with product and methods of preventing same are receiving a great deal of attention. Studies of various places in the product laboratory and Room B of the separation plant show α contamination of desk tops, jackets of centrifuges, gloves, handles of apparatus

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4.

air, etc. A rugged type of portable α -ray detector is needed for all places when product is used. The Health Division, Chemical Division and Instrument Groups both at Clinton and Chicago are cooperating in developing such instruments. The most important procedure now is for the personnel to protect themselves by extreme precautions including masks when work is not done under a hood.

"Vinylon" has been found by the Chicago group to be an acid resistant cloth that can be decontaminated easily and hence may prove useful for coats and towels.

Clinical Biochemical Studies

Liver function tests (colloidal gold, cephalin-cholesterol, and formol-gel) have shown some positive reactions in personnel exposed to radiation and toxicological hazards, but the tests have not yet been tried widely enough to gauge their significance.

Pigment metabolism studies show that (a) project workers exposed to lead or radiation tend to have definite increase in red blood cell protoporphyrin, (b) no essential change in urine coproporphyrin, (c) 17 out of 43 project workers showed positive urine uroporphyrin tests compared to 1 of 12 controls.

Kidney function tests by urine sulfur excretion methods have been negative so far as personnel are concerned but positive for rabbits receiving relatively large injections of tubanyl nitrate.

Initial studies of blood proteins by the electrophoretic method indicate some changes possibly due to radiations.

Biological Research

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The use of heated T_3O_8 to produce Xe has been set aside to further test $T(OH)_4$ at pile operating temperatures.

Inhalation experiments are still in the "study of method" stage.

5 mC ($25 \times 10^{-6}C/gm$) of mixed f-products by stomach tube killed rats; apparently by damage to stomach and intestines because very little was absorbed. 0.64 mC did not kill them.

$Ba^{140} - La^{140}$ in equilibrium, given to mice by intraperitoneal injection kill the animals with amounts of the order of $17 \mu C/gm$. The retained activity is mostly in the bones. Lymphocytes are affected early, polymorphs later. On the other hand, the bone marrow destruction was most complete and occurred very early.

Total body radiation with external β rays has its earliest effect on eyes of rabbits. 600 r seems to be the minimal effective dose.

Stable cerium and barium are toxic to goldfish in concentrations of 10 ppm (by weight) and non lethal in 30 days at concentrations of 1 ppm.

Sr^{89} and $Ba^{140} - La^{140}$ are taken up rapidly by goldfish initially. The high point is not reached, because for several weeks the fish continue to take up more even though the water concentration is decreasing. The skin and scales contain the greatest concentrations of both (40 - 75%). For strontium the skeleton contains the highest concentration and for barium-lanthanum the organs and muscles. The feces become highly contaminated apparently by adsorption, reaching 1000 times the water concentration.

Bar Harbor mice have a 50% lethal dose of 117 n of pile (Clinton) neutrons and about 800 r of pile (Clinton) gamma rays. Exposure to mixed neutron and gamma ray radiations in the pile give confusing results since one experiment showed only partial additivity and the other showed more than total additivity.

A method of preparing a good fixed source of beta rays for testing external effects of these has been devised. Red phosphorus powder mixed with lucite (100 to 120) can be made into sheets and exposed in the pile. A satisfactory yield of P^{32} results.

It has been found that the fission recoil apparatus delivers not only gaseous parents of fission products but also normally solid fission products which have no gaseous point, such as tellurium.

"Pure" fission products are now being separated at Clinton and used there and in Chicago for biological studies: 40 mC of Sr, 18 mC of Sr plus Ba; considerable "super-juice" (mixed fission products free from tuballoy).

The rabbits in pile stack gases are receiving about 0.6 r/day of external beta rays plus an unknown amount of unknown elements into the body.

University of California Radiation Laboratory

Final reports on the metabolic studies of columbium, cesium, barium, praseodymium and emanation studies have been completed and will appear as CH reports in the next month.

Attempts at removing Yttrium and Cerium from the body have so far been unsuccessful.

30% of the fission activity in powdered tuballoy was found to be volatilized by using a carbon arc. When this smoke was inhaled the various fission products were found to behave in the same manner as when injected separately into the lungs in solution.

Product studies: - Oral absorption of all valence states is less than 0.05%; lung retention high; absorbed material predominately in skeleton; excretion very small in urine and feces.

Health Physics and Radiation Measurements

Pocket meter service is expanding both at Clinton and in Chicago.

6.

The percent of off-scale readings for February at Clinton was 2.7 for single meters and 0.1 for double meters. The statistically probable percent of "double events" is 0.07. Thus with two meters per individual good accuracy is possible. By the use of single meters plus cooperation on the part of the group leaders, etc. in checking man's action a fair record of each individual's exposure is possible.

Parker's section has found that at 35% humidity there is no leakage of pocket chambers, with or without dessicator but that at 75% humidity there is trouble without dessicator.

Projection minometers have been found to have the following defects: (1) charging voltage changes with time, (2) the charging button sticks too frequently, (3) repair and replacements of rectifier circuit is unsatisfactory.

Both at Clinton and Chicago it has been found that Lauritsen electroscopes require a complete calibration chart for all intensities if they are to be interpreted accurately. Moreover, the calibration for γ rays does not correspond with that for beta rays.

Methods of surveying for α rays are receiving a great deal of attention. In addition to α ray counter the Clinton group have developed an electroscopes (modified Lauritsen) to test table tops, etc. At Chicago Dersham electrometers and Wollan-Landsverk electroscopes are being tried out.

Atmospheric surveys at Clinton have shown no appreciable activity to date.

Surveys of activities of all kinds have been routinely conducted throughout the Clinton and Metallurgical laboratories, including the Argonne gas.

At Clinton it has been found that in tanks of "average" chemical solutions 100 curies of 2 MEV beta activity the gamma radiation by Bremsstrahlung is the same as from 1 curie of 2 MEV gamma activity. This must be taken into consideration in shipments of large quantities of beta emitters.

N. C. I.

Breeding experiments are showing possible irradiation effects in reduced litter sizes. The effects are more severe with more intense radiation. With 8 r per 8 hours the same effect is found from 500 r total as from 800 r when given at the rate of 8 r per 24 hours. Male mice receiving 1600 r at 8 r per 8 hours do not mate for a period of approximately two months, but subsequently matings result in a normal litter size production. Female mice receiving 300 r as a single acute whole body exposure remain fertile for not more than two months but then become sterile with apparently no recovery. Mice exposed to doses of 4 r and less per 8 hours still show normal blood pictures while those

getting 8 r show definite decreases. Mice getting 4 r in one hour out of each 24 show a normal blood picture. One animal in the group developed a leukemia. Rabbits getting 8 r per 8 hours and having received approximately 2000 r still have normal blood findings. At least the abstract of the N.C.I. report should be read as it is too complicated to synopsise.

Memorial Hospital

Two patients are under observation, getting 10 r per 24 hours.

U. of C. Hospital

In addition to the previous patients treated on the 100 and 200 KV machines, some further patients are being given total body radiation on the 1000 KV apparatus.

Meteorology

The Meteorological work is continuing at Site W. Arrangements are being made to study dilution from the stack by means of SO₂. Further observation has shown that the most dangerous time so far as concentration is concerned is in the early morning, just as the cloud inversion is breaking up, the vertical circulation starts. It has been found that the up and down drafts bring the smoke to the surface in dense columns within the 200 W area itself.

Note:

For Clinton Laboratories Health Report see CH-1470 (A-2060).

B. CLINICAL MEDICINE AND MEDICAL RESEARCH

C. J. Watson, M.D., Associate Director and Section Chief

L. O. Jacobson, M.D., Acting Section Chief

Report for Period Covering January 15 - February 29, 1944

A. Clinical Section - J. J. Nickson, M.D. and M. J. Nickson, M.D.

1. Pre-Employment Examinations

During the period January 15 - February 15, 1944, 189 examinations were done. Thirty-nine of these were on academic personnel, 130 on non-academic personnel. Six applicants were rejected.

2. Health Surveys off the Project

From February 1 - 2, a radium dial painting plant was visited. The trip was planned to obtain background for the planning of New Chemistry alterations. On February 3, a metal machining plant was inspected. Details of this report will be found in the Clinical Section of the Clinton report.

On February 21, the St. Louis Cyclotron was visited. The main purpose of this trip was to discuss the possible effects of radiation with the cyclotron crew. Inspection of the men's hands revealed no detectable change.

3. Liaison Committee Meetings

No attempt will be made to discuss the Committee reports in detail. Those interested will find the minutes on file in the Library.

Dr. Pardue made 24 surveys at the request of the Committee. In two instances, the surveyor felt that over-exposure was probable.

Dr. Schwartz was asked to survey 23 individuals by the Committee. His findings will be found in his section of this report.

Three product accidents were discussed in the minutes. During the month, Mr. Pyle joined the Committee. He will be responsible for disposal of waste active materials, discussed below.

Dr. M. Nickson reported on the literature of the toxicity of biphenyl and acenaphthene at the request of the Technical group.

Trichlorethylene Hazard

Site B, room 135, has a Blakeslee degreaser which operates with trichlorethylene. The usual tolerance figure given is 200 parts per million in air. On February 17, 1944, Mr. Goldberg of the Illinois Department of Public Health determined the amounts of trichlorethylene in air at various times during the operation of the degreaser. The highest value obtained was 138 p.p.m.

MUC-HQ-392 gives the details of this survey.

Radiation Over-Exposure Records

During the past month, a new system of checking the persons having chamber readings of greater than 100 milliroentgens was instituted. A letter is sent to the exposed individuals's group leader requesting information concerning: (1) the person's activities on the day of over-exposure, (2) knowledge of accident to the chamber, and (3) group leader's evaluation of the correctness of the reading. A monthly summary of this information will be presented in future reports.

Acid Resistant Cloth for Protective Clothing

During the month, the idea of obtaining an acid resistant cloth which could be decontaminated by rinsing in strong acid solutions was developed. A search, aided by Mr. Kimpton's Office, showed that Vinyon, a polymerized vinyl acetate, was the most likely available woven material. Decontamination tests with both product and fission products were carried out by this group and Dr. Pardue's group. Details of the tests are found in Dr. Pardue's report. In brief, the tests indicated that all of the samples could be decontaminated with ease.

Because of the expense involved (\$16.00 per coat, estimate) and because of uncertainties as to the material's resistance to ordinary wear, a "scout" order of but 100 coats and 50 towels was placed. Vinyon 26 was selected. It would seem that Clinton and Hanford might be able to use this or a similar material to good advantage.

If subsequent experience indicates that widespread use of such coats would be desirable, a larger order can be considered.

Tuballoy Dust Survey

During the month, a non-academic employee was added to the personnel of the Clinical Group. It is planned to expand the monitoring of amounts of Tuballoy dust in air. For the most part, the monitored locations will be in Site B. Mr. Tourek will spend one-half of his time on this work.

Finger Printing Study

Mr. Tourek will devote one-half of his time taking Finger Prints. The impressions will be sent to Dr. Roger A. Harvey for interpretation.

Projected Work for Month

1. Continuance of pre-employment exams.
2. Continuance of Metallurgy Laboratory surveys.
3. Continuance of Product Hazard surveys.
4. Expansion of Finger Print program.
5. Expansion of Tuballoy dust surveys.

B. Hematology - L. O. Jacobson and E. Marks

The clinical hematology group examined 1107 individuals during the period 1/15/44 to 2/15/44. The following table gives an analysis of the laboratory examinations made:

No. of Exams.	Hgb.	RBC	WBC	Differentials	Platelets	Urines	Retics.	Wass.
	685	600	970	970	135	700	50	200
				Misc.				10

Two individuals showed blood abnormalities possibly due to over-exposure to radiation. The first occurred in a person working with a gram Ra-Be source. Since this work has stopped, his white blood cell count which had fallen has risen in the direction of normalcy. The second person was overexposed to a Rn source. There was a small drop in the total leucocytes and a marked change in the P/L ratio. This has slowly corrected itself.

C. Electrophoretic Studies of Proteins - E. S. Guzman Barron and John Muntz

There is evidence, from the published literature, that serum proteins change in distribution as a consequence of X-ray treatment. It is our purpose to follow these changes by electrophoretic analysis of the proteins both in patients receiving X-ray therapy and in animals treated with X-rays. We are well aware that in patients it will sometimes be impossible to obtain the control analysis. However, data for electrophoretic distribution of serum proteins obtained by a number of investigators agree so closely that the normal values of this laboratory can be used as control values.

One patient, J. M., has been studied on different occasions after he received X-ray therapy. Unfortunately we do not have the serum electrophoretic pattern before radiation started. On Nov. 26 and 27 the patient received two X-ray applications of 100 r each; on Dec. 16, 17, 18 and 20 he received 75 r each day; on the 25th he received a blood transfusion. The serum proteins were determined electrophoretically on seven different occasions from Dec. 15 to Dec. 27 (Table I). On Dec. 15, 18 days after X-ray therapy the distribution of serum proteins was about normal. On Dec. 16, the day after application of 75 r, there was a profound modification in the distribution of serum proteins, characterized by a decrease of albumin and an increase of globulin. Whether this was due to the action of X-rays or not cannot

11.

be decided until more observations are made. This pattern was maintained with some modifications; the last sample of blood, taken 7 days after radiations stopped there was still some decrease in albumin and increase in γ globulin. Two patterns accompany this report: one, of J. M. on Dec. 24; the other from a normal serum. The distribution of serum proteins of another patient (J. G.) is being studied. Unfortunately this is a patient with carcinoma of the stomach where there is ordinarily an increased γ globulin.

The effect of radiation on the distribution of serum proteins cannot be reasonably determined unless we find an animal having a constant electrophoretic pattern. The dog had to be discarded because the serum has four to five globulins which seem to change from one to the other. We are now studying for this purpose the electrophoretic patterns of the serum proteins of the rabbit, the rat, and the goat. Rabbit sera was analyzed at the following ionic strengths: 0.05, 0.06, 0.075, 0.1 and 0.15. In general, only three components were observed regardless of the serum concentration. Furthermore there was no constancy in the mobility of the protein components. Goat serum was analyzed at ionic strength 0.075. Four components were observed which separated from each other to allow their measurement. The mobilities of the protein fractions resembled those of human serum. Rat serum was analyzed at ionic strength 0.075. Further work will be done with this animal. It is our opinion that work on the effect of radiation on blood proteins must be concentrated to studies on the goat and the rat.

Table I

Distribution of serum proteins of J. M. from electrophoretic analysis.

Date	Total protein %	Percent			
		Alb.	Glob.	B. glob.	γ glob.
12-15-43	6.97	63.0	5.7	11.5	19.9
Radiation 75 r 12-16-43	5.74	47.9	5.4	16.4	30.2
Radiation 75 r 12-17-43	6.85	57.5	1.5	10.7	30.2
Radiation 75 r 12-18-43	5.46	64.1	2.7	7.5	25.5
Radiation 75 r Dec. 20 12-22-43	6.12	48.4	5.6	14.9	31.2
12-24-43	5.55	50.2	5.8	12.3	31.7
12-27-43	6.63	57.1	7.4	10.7	24.8
<u>Normal values</u>	7.00-7.60	62.5-65.5	6.2-7.9	12.6-15.2	13.1-15.7

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Electrophoretic patterns of Blood Serum

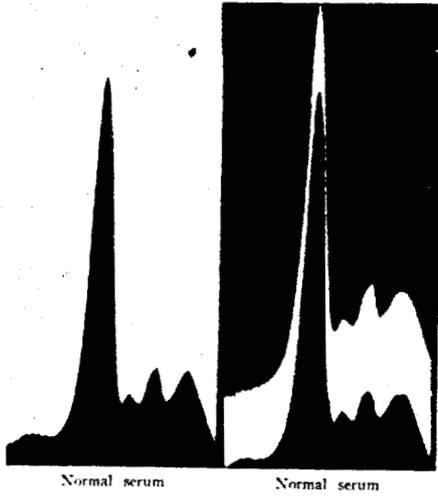
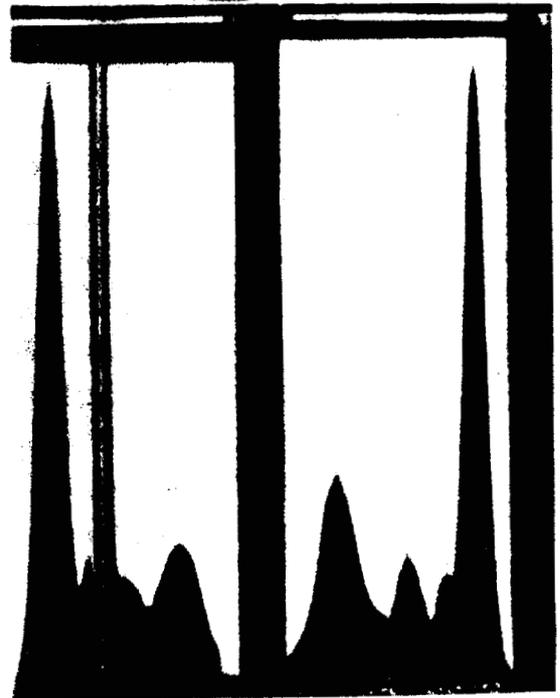


FIG. 1. NORMAL SERUM



Patient J. M. Dec. 24, 1943

D. Toxicology Group: Albert Tannenbaum, H. Silverstone

The chronic feeding experiments on the toxicity of various T compounds are being continued, and are now in their fifth month. The toxicity of single subcutaneous injections of T compounds is being studied, including the effect of second injections. A program of inhalation studies is being investigated.

E. Report of Biochemical Group: S. Schwartz

The study of numerous tests which aim at the early detection of exposure to and toxicity from radiation and metal has continued along the general lines previously outlined. The results of these studies to date are summarized below.

In these studies the control series consists of 14 medical students, several non-exposed members of the project staff, and a few newly employed project members. It is recognized that some of the latter, at least, may not have been perfectly "normal." The exact number of controls for each test are shown on the appropriate figure.

The project members investigated have been those believed most likely to yield positive results. For radiation effects the groups of Mr. Cunningham and Sugarman in New Chemistry were studied. The group in Room 109, Site B, was studied because of considerable tuballoy dust exposure. In addition, several individuals were investigated because of exposure to lead or various chemicals.

I. Liver function studies.

A. Serum proteins - (with L. Schneider and J. J. and M. Nickson)
Three tests have been studied to gain insight into both qualitative and quantitative protein changes in project personnel, namely, colloidal gold, cephalin-cholesterol, and formol gel. The first two of these tests, at least, have been shown to be commonly positive in liver disease as a consequence, chiefly, of altered serum globulin.

1. Colloidal gold test.

The method used is that described by S. Gray (to whom we are indebted for aid in preparing our solutions). Three serial dilutions of serum are used, with results expressed in terms of 0 - 5 depending on the color change and amount of precipitation present. Normally all of the tubes will read 2 or 3. A weakly positive test is indicated by a reading of 4 or 5 in the first tube. With increasing liver dysfunction the second and third tubes read 4 and 5 also.

In none of the control series was a positive test obtained. On the other hand, 12 of 42 project members

studied had at least a weakly positive test. This is illustrated in Fig. 1 where the number in each group is plotted against the sum of the 3 tubes. With this scheme only 8 are seen to fall outside the normal range. It might be pointed out here that only 3 of this group had a positive cephalin-cholesterol test, (2 plus or more).

2. Cephalin-cholesterol

The method of Hanger has been modified to include 8 tubes with serial dilutions containing from 0.2 to 0.0001 cc. of serum. Results are read in terms of 0 - 4 plus depending upon the amount of flocculation and clearing present. A 2 plus or greater reading in the first tube is believed indicative of liver dysfunction.

Although to date the first tube only appears to be significant we are for the time being plotting our data in terms of the sum of the first 3 tubes.

In none of the normal controls studied has a 2 plus or more test been encountered. In 8 project members 2 plus to 4 plus flocculation has occurred. The test was repeated at a later date in 2 of these 8 with positive results again. It might be pointed out that only 2 of these 8 had a positive colloidal gold reaction, indicating again a different mechanism for the two tests.

Strongly positive tests (3 - 4 plus) were obtained from the sera of two individuals exposed to considerable tuballoy dust in Room 109, Site B. A 4 plus reaction was also obtained on one individual exposed to lead. The data is illustrated in Fig. 2.

3. Formol gel

The emptying time of serum from a modified white blood cell pipette is measured before and about 6 hours after the addition of a drop of formaldehyde. The ratios of these two times is dependent upon the globulin content of the serum. As shown in Fig. 3, the ratio in project members has been found to vary widely from about 1.0 - 1.7. Four have been over 2. Our normal control series is still too small to permit any conclusions to be drawn.

Protein studies in dogs and rabbits exposed to either radiation or metal have yielded no worthwhile information. Both species normally have a 3 - 4 plus cephalin cholesterol test. In acute experiments in rabbits no change has been noted in the colloidal gold test. Isolated observations indicate a marked increase in sedimentation rate following tuballoy injection. This point is being studied further at the present time.

II. Pigment Metabolism Studies (with E. Katz, F. Felter and M. Mandel)

A. Red blood cell protoporphyrin

The most marked increases in red cell protoporphyrin have been encountered in workers exposed to lead. Thus 2 of 4 workers in the foundry Room 42 in Ryerson had levels of above 65 gamma per cent, (normal level 15-30 gamma per cent). Other high values have been encountered in personnel receiving relatively large radiation exposure of chronic type. In general it can be said that, compared with medical students, exposed project members have relatively high red cell protoporphyrin levels. This is illustrated in Fig. 4.

It might be noted that only one of the control group had a value above 33 gamma per cent, and his protoporphyrin level was up to 65 gamma per cent. A repeat determination 4 days later showed a fall to 41 gamma per cent. While the explanation for this increase is uncertain, it might be noted that he had had an acute bronchitis 4 days earlier for which he had taken 8 grams sulfathiazole. It is believed that this is sufficient to exclude him as a control.

B. Urine coproporphyrin

Project members with a few exceptions, appear to have a relatively normal urine coproporphyrin excretion. At the present time this is being quantitated from an aliquot of a 3 hour afternoon specimen. Most of the studies done to date are on 24 hour collections.

In Fig. 5 the data is given in terms of coproporphyrin concentration in the urine. The highest concentration (19.5 gamma per cent) was found in the urine of Mr. Y., exposed to considerable trichlorethylene fumes at Site B.

Coproporphyrin studies on rabbits receiving subcutaneous injections of tuballoy nitrate are illustrated in Fig. 6. These graphs might more properly be included in the section on kidney function, since the damaged kidney will not excrete coproporphyrin. This undoubtedly is the explanation for the marked fall observed, despite any tendency which might have been present to cause an increased excretion because of tuballoy toxicity. Experiments are now in progress to determine whether doses of 0.25 mg/Kg or less will cause an increased coproporphyrin excretion which will not be inhibited by kidney insufficiency.

C. Urorosein

Urorosein is a red compound formed in strong acid solution from oxidized indolacetic acid. Its exact clinical significance is unknown but it often appears to be associated with dietary deficiency. The urorosein test is performed by extracting a 100 cc aliquot of urine with ether $\times 3$ following acidification with 15 cc glacial acetic acid. The ether is first extracted repeatedly with 10% HCl to remove the porphyrin, and then with 25% HCl to remove the urorosein. A positive test is indicated by a red color with absorption maximum at 543 m μ . Using the Evelyn photoelectric colorimeter maximum absorption is obtained using the 520 m μ filter. Because the 25% HCl extract contains numerous pigments in addition to urorosein, we have been measuring its absorption in the Evelyn colorimeter using various filters.

Urine sulfur has been quantitated using the nephelometric method of Freon and Crutchfield. Blood sulfur has been quantitated by a modification of the method of Denis, using 20 - 30 mesh barium chloride rather than 10% barium chloride to precipitate the sulfur.

- a. A study of 3 rabbits who received 4 mg/Kg tuballoy nitrate.

All died from 12 - 15 days following oliguria or anuria of several days duration. The number of sulfur determinations done following the injections was very small but indicated a marked drop in sulfur excretion. Thus average control levels of 100 - 150 mg per cent fell to 2 - 36 mg per cent before death.

Since the blood sulfur method was not available at the outset, control determinations on the injected animals were not obtained. However, postinjection levels on the injected rabbits and on 3 control animals reveal a marked increase in blood sulfur as demonstrated in Fig. 7.

- b. A study of 3 rabbits who received 1.5 mg/Kg tuballoy nitrate by subcutaneous injection.

As shown in Fig. 8 all 3 rabbits had a marked fall in urine sulfur concentration. The sulfur level of I-14 and I-16 rose shortly to normal and these animals have shown apparent complete recovery. Sulfate excretion of I-15 remained low. He died 17 days after the injection.

Attention is called again to the reduction in urine coproporphyrin; following tuballoy injection. (See Fig. 6)

IV. Phosphorus studies - (with L. DeGrazia and A. Edwards)

Abels et al have reported a marked increase in the organic acid soluble phosphorus of white blood cells following total body radiation of as little as 3 r to leukemic patients. They were, however, unable to adapt their method to the small number of white cells in normal blood.

A simple procedure has been worked out for quantitating several phosphorus fractions in the white cells of less than 1 cc normal blood. Both human and animal studies are in progress and will be reported next month.

V. Individual scoring.

In the table which follows, the results of our studies of representative members of 4 groups of exposed and non-exposed individuals are summarized in terms of 0-4 + reactions. The following significance may be attached to each of these figures:

- 0 = Definitely normal range
- 1+ = Borderline values
- 2+ through 4+ = Increasingly positive reactions

In order to arrive at a composite value which will roughly represent the individual's reactions to the various tests used, the following method of scoring has been devised:

Cephalin cholesterol 1 - 4+ with increasing flocculation as described by Hanger.

Colloidal gold: Sum of 3 tubes.

- 0 = 5 - 8
- 1+ = 9 - 10
- 2+ = 11
- 3+ = 12 - 13
- 4+ = 14 - 15

RBC protoporphyrin in gamma per 100 c.c. erythrocytes

- 0 = < 30
- 1+ = 30 - 40
- 2+ = 40 - 50
- 3+ = 50 - 70
- 4+ = > 70

Urorosein and associated pigments

Evelyn reading at 400 mμ and 520 mμ

<u>400 mμ</u>	<u>520 mμ</u>
0 = 100 - 60	0 = 100 - 75
1+ = 60 - 50	1+ = 75 - 60
2+ = 50 - 30	2+ = 60 - 40
3+ = 30 - 20	3+ = 40 - 25
4+ = 20 - 0	4+ = 25 - 0

Urine coproporphyrin in gamma per 100 c.c. urine.

0 = < 8

1+ = 8 - 10

2+ = 10 - 13

3+ = 13 - 18

4+ = > 18

Group I. Controls. Normal medical students

Subject	Cephalin-cholesterol*	Colloidal gold*	R.B.C. proto-porphyrin	Urine copro-porphyrin*	Spectroscopy "uroseoin" fraction		Abs. 510 mμ	Score
					400 mμ	520 mμ		
1.	0	0	1	0	0	0	0	1
2.	1	0	0	0	0	0	0	1
3.	0	0	0	0	0	0	0	0
4.	0	0	0	0	0	0	0	0
5.	0	0	0	0	0	0	+++	1
6.*	0	0	3	1	1	0	0	5
7.	1	1	0	0	0	0	0	2
8.	0	1	0	0	0	0	0	1
9.	1	1	1	0	0	0	0	3
10.	1	0	0	0	0	0	0	1

Group II. Controls. Project members with what is believed to be relative by slight exposure.

1.	1+	0	0	0	0	0	0	1
2.	0	0	1+	0	0	0	0	1
3.	0	0	0	0	0	0	0	0
4.	0	0	1+	0	0	0	0	1
5.	0	0	0	0	0	0	0	0

Group III. Predominant exposure: T-dust and chemicals. (Site B) Project members.

1.	1+	2+	1+	3+	2+	2+	+	12
2.	4+	1+	1+	2+	2+	3+	+	14
3.	1+	2+	2+	0	1+	1+	+	8
4.	3+	1+	0	0	0	0	+	5
5.	1+	0	0	4+	3+	4+	+	13

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Group IV. Project members. Predominant exposure:
radiation and chemicals. (New Chem.)

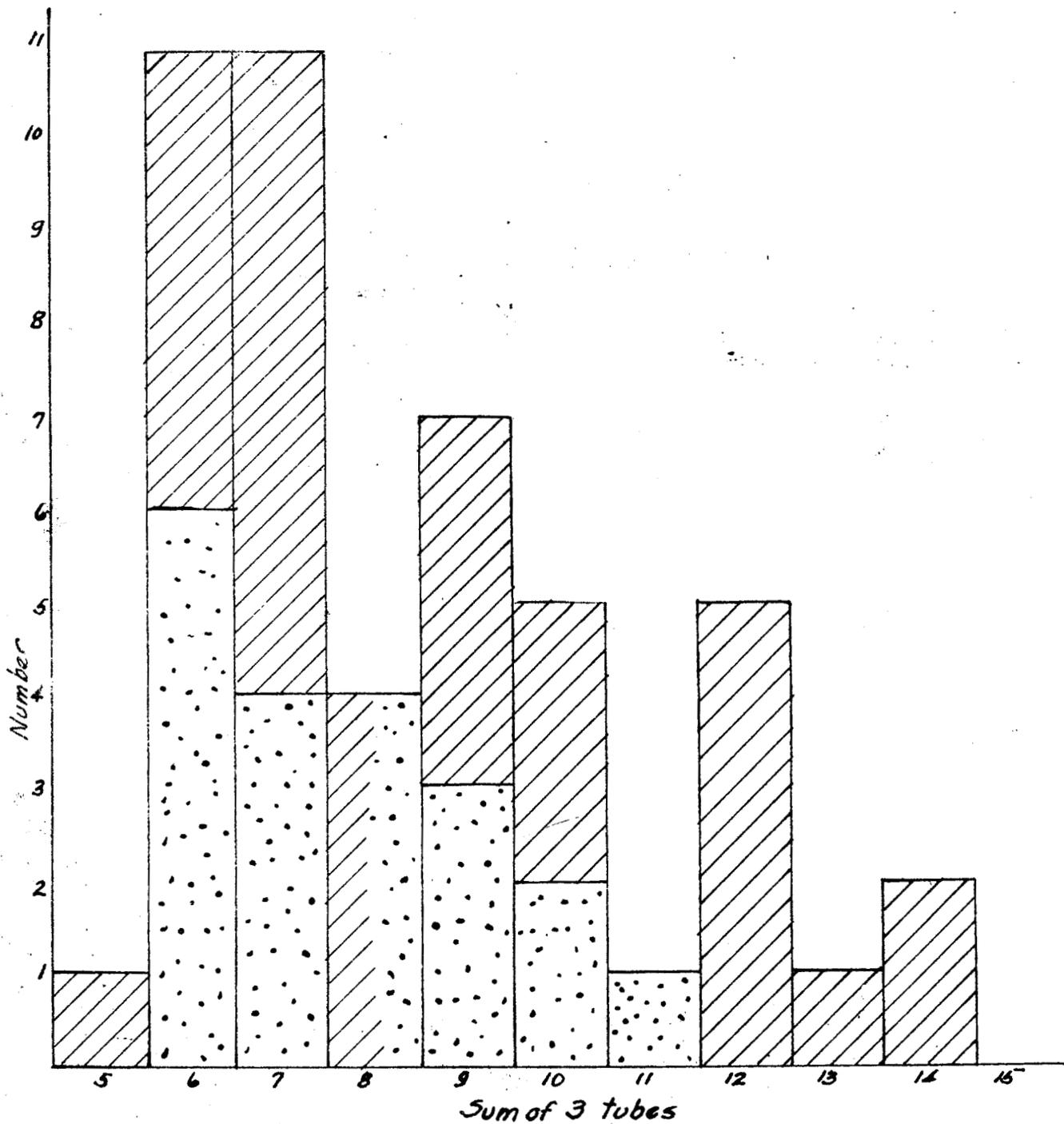
Subject	Cephalin cholesterol*	Colloidal gold*	R.B.C. proto- porphyrin	Urine copro- porphyrin*	Spectroscopy "urorosein" fraction		Abs. 510 m	Score
					400 m	520 m		
1.	1 +	3 +	2 +	2 +	1 +	1 +	0	10
2.	1 +	1 +	0	1 +	2 +	2 +	0	7
3.	1 +	0	2 +	1 +	3 +	3 +	0	10
4.	0	3 +	3 +	0	0	0	0	6
5.	4 +	4 +	-	1 +	4 +	3 +	0	16

* 8 grams sulfathiazole 4 days previously
 ** weak absorption only after standing 48 hours

Summary

A high incidence of project members exposed to relatively large amounts of radiation, tuballoy, or chemicals have been found to have positive reactions to several different tests. These indicate an effect of some kind on the liver, kidney, or hematopoetic systems. In general, a "positive reactor" will be positive for several different tests. Data is as yet insufficient to ascertain the seriousness of these positive results, though it should be emphasized that most of the deviations from normal are only moderate.

FIGURE 1
Colloidal Gold Test
(Human Studies)



Controls

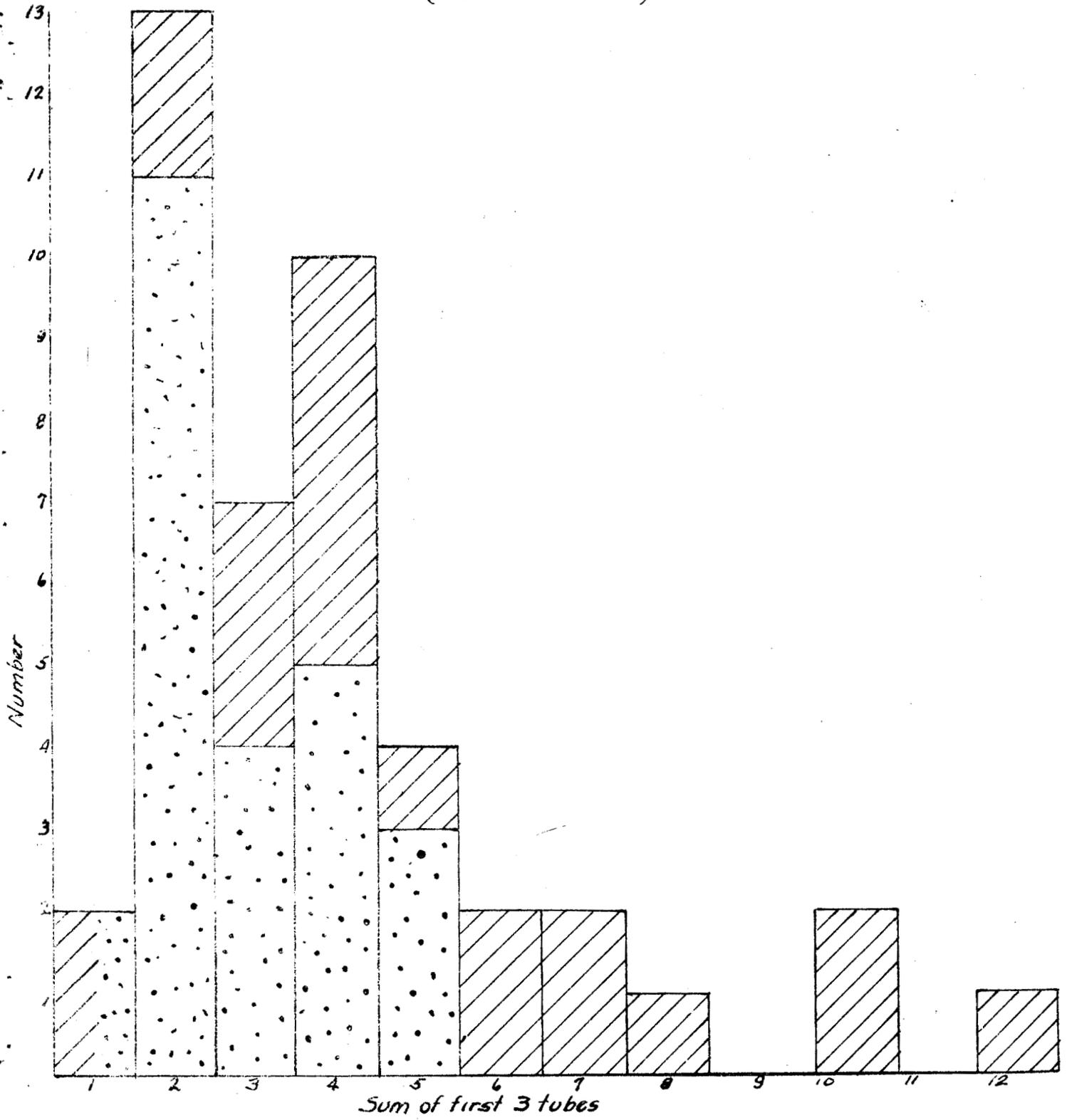


Project Members

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FIGURE 2

Cephalin Cholesterol Test
(Human Studies)



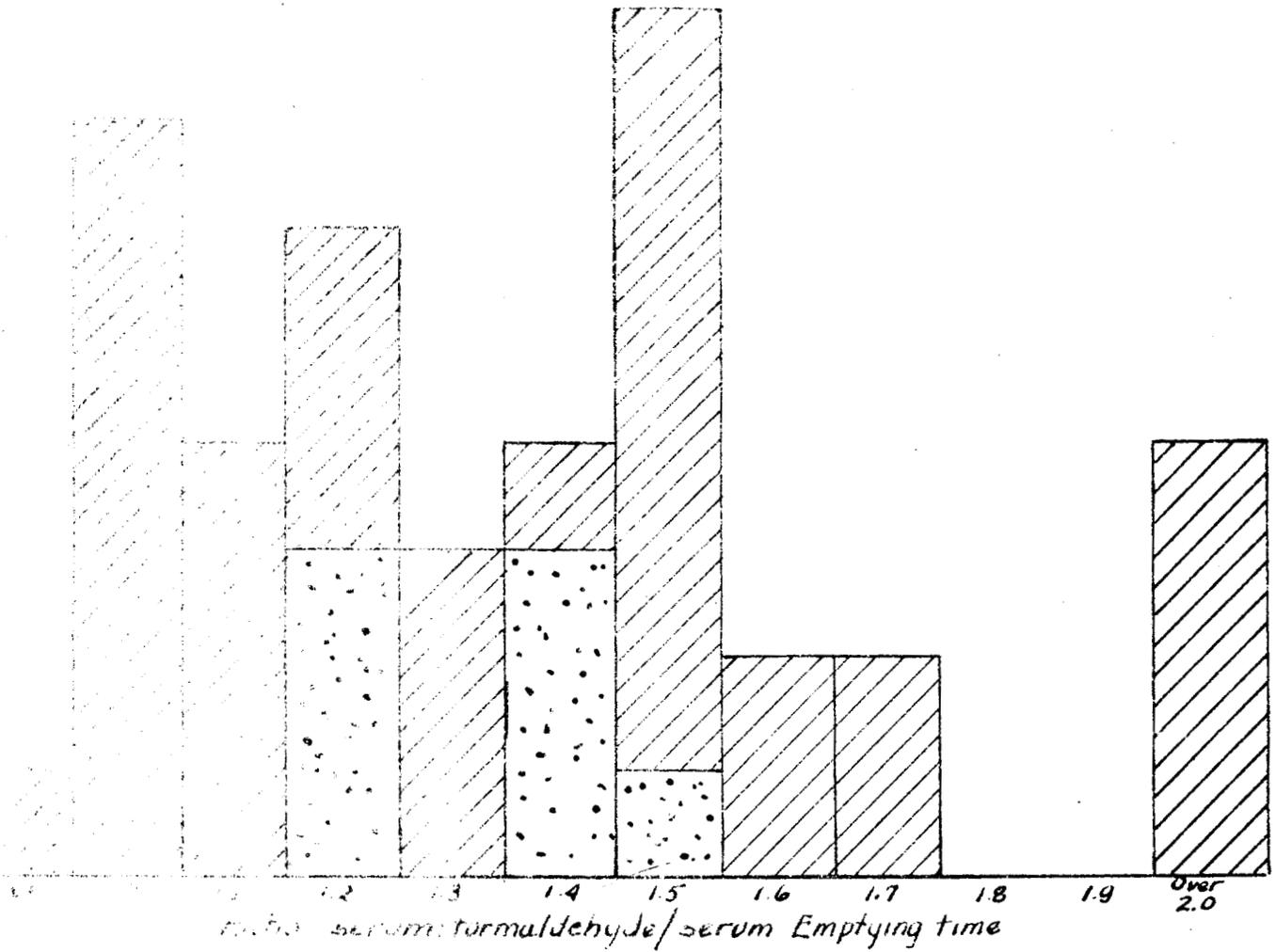
Controls

Project Members

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FIGURE 3

Formol-Gel Test
(Human Studies)



 Controls
 Project members

FIGURE 4

Red Blood Cell Protoporphyrin
(Human Studies)

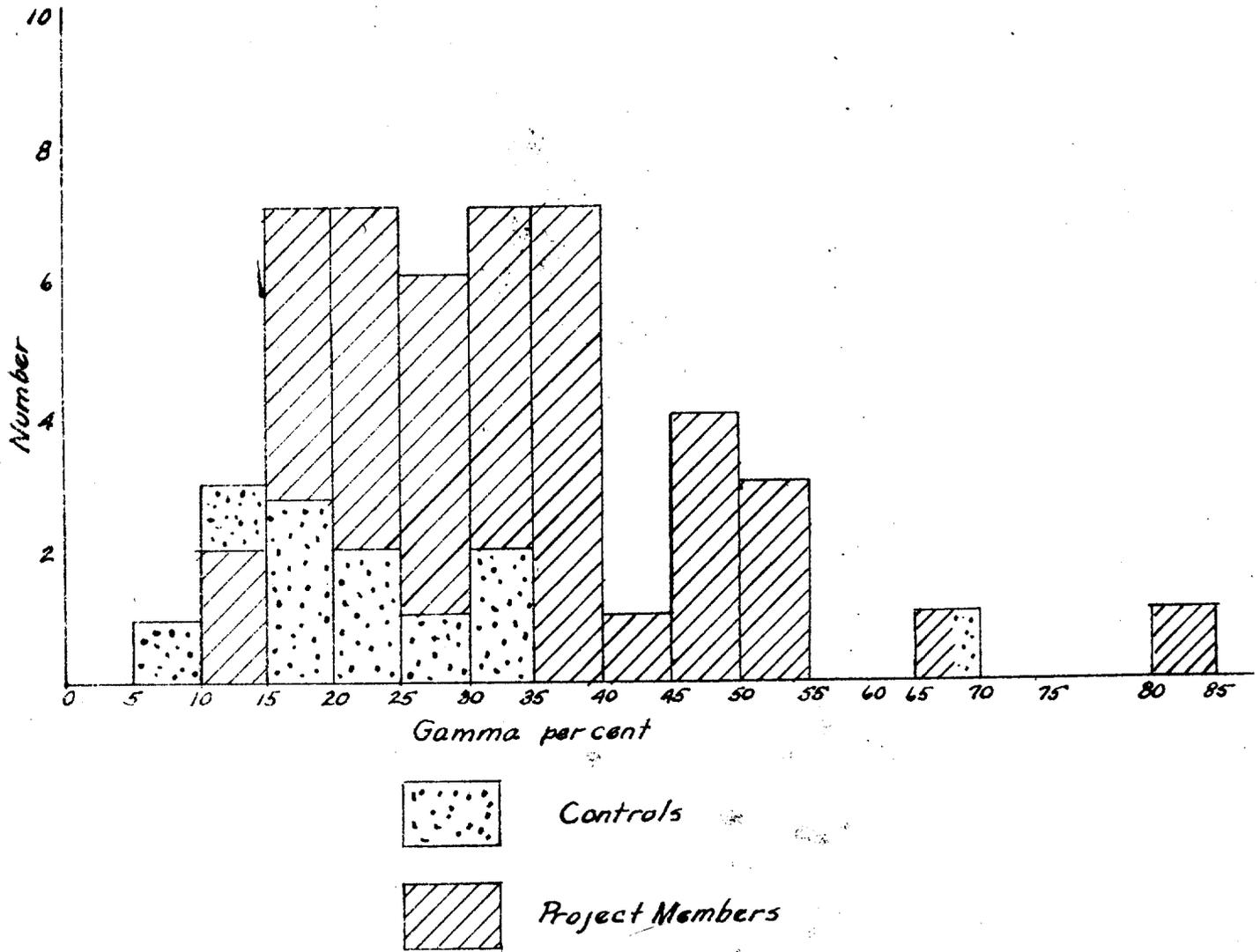


FIGURE 5

Urine Coproporphyrin Concentration
(Human Studies)

