I enjoyed designing and building this machine, and I believe that I have gained invaluable experience from it. In the future I plan to improve this machine and design and build others. This experience will be of great value to me, as I intend to go into this field in my future life at least as a hobbyist.

FORCED FEEDING OF IRRADIATED RATS

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INTRODUCTION

During the summer of 1955, I had the opportunity to learn something about scientific research while doing volunteer work in the Biochemistry Laboratories at Vanderbilt Hospital. While there, I became interested in a problem that arose and was allowed to do experiments on it. Before the experimentation began, I was carefully taught all techniques and checked on them. However, once I began my project, I did all the work myself. Before beginning the tests, I skimmed through the *Nuclear Science Abstracts*, *Chemical Abstracts*, and *Biological Abstracts* for what had previously been done on my problem. I then chose the titles of relevant articles and read the reports.

I would like to express my appreciation to Dr. Granville W. Hudson, who did all irradiation for me, to Dr. H. C. Meng, who supplied the fat emulsion which I used, and to Dr. John Coniglio, whose interest and confidence in me enabled me to stay cheerful when the work seemed hard or discouraging.

Technical terms used in this report are as follows:

r = the amount of radiation that will ionize a fixed volume of air at standard conditions.

Leucocyte counts = white cell counts.

Hematocrits = the percentage of red cells in the blood.

LD/50/30 days = lethal dose that will kill 50% of the animals in 30 days.

FORCED FEEDING OF IRRADIATED RATS

Immediately following a large dose of total body irradiation, rats eat little or nothing at all. The question has thus been raised: could the animals use food advantageously enough to decrease the mortality rate or at least to increase survival time? If so, we though that the answer to the problem of weight loss and early death might lie in forced feeding by stomach tube. Smith, Tyree, Patt and Bink (1) reported that forced feeding of a semi-fluid diet (composition not stated) to rats pretreated with cysteine and x-irradiated with 800 r, reduced post-irradiation

weight loss. However, when rats were fed this semi-fluid diet or a preparation of protein hydrolysate-dextrose, death of all rats within four days post-irradiation resulted. Smith, Ackermann, and Smith (2) observed that force-feeding of a casein diet to rats x-irradiated with 750 r resulted in higher mortality rates and shorter survival times than in irradiated controls. A partially pre-digested diet consisting of Amigen and dextrine proved definitely detrimental when given to the animals on the first three days post-irradiation and of little influence in the following days.

Protein or a protein derivative was the main dietary component used in the studies cited above. It is also important to determine the possible use of other dietary materials in irradiated animals. Since fat absorption had been proved normal following irradiation (3), it was thought that a fat emulsion might be more beneficial than protein derivatives. Small quantities of fat give a higher number of calories than equal amounts of protein or carbohydrates.

Experiment I

Methods

Twelve male Sprague-Dawley rats, weighing approximately 200 grams, were given 750 r total body irradiation at 40 r per minute. The source was a Co-60 therapy machine. Involved factors were as follows:

1. The rats were irradiated two at a time.
2. They were irradiated in a woden box.
3. The time of irradiation was 18.75 minutes.
4. The distance from the source to the target was 53 cm.

All rats were individually caged and divided into three groups of four. All groups were offered approximately 25 grams of ground Purina dog chow per day.

In addition, Group I was tube-fed an emulsion containing 30% cottonseed oil and 5% glucose. Forced feeding began the morning following irradiation and was continued for six days, at which time the food intake returned to normal. 2 ml., containing approximately six calories, were given each animal per day. They furnished approximately 25% of the daily caloric requirement.

As the procedure of stomach tube feeding in itself might be detrimental, Group II was established. Four rats were force-fed H_2O under the same conditions as Group I.

Group III was also irradiated but not force-fed anything. A group of normal rats (Group IV) served as non-irradiated controls. In view of the possibility that the emulsion might be harmful, this group was tube-fed 2 ml. of the fat emulsion per day.

The animals were weighed the day before irradiation, the day of irradiation, and approximately every three days following irradiation. A record of food intake was kept from day to day. Leucocyte counts and hematocrits were taken pre-irradiation and at intervals post-irradiation.

Results

Only one rat (Group III) died from the exposure to the Co-60 irradiation. Weight loss varied only slightly among the four groups. Apparently the force-feeding had no influence, beneficial or otherwise.

The hematological findings also showed no significant differences in irradiated animals. The leucocyte counts dropped severely from the pre-irradiation levels to those taken on the 1st and 2nd days following irradiation. They remained low until the 8th or 9th day and then rose swiftly to normal. By the 27th day, all cell counts and hematocrits had returned to near normal values for rats of this size.

Groups I, II, and IV had a lower food intake on the days of force-feeding than Group III. On the day after irradiation, all irradiated rats ate very little. Food consumption of the animals which were not force-fed returned to normal on the third day; that of the other groups rose gradually, and returned to normal soon after the tube feeding was discontinued. The data are summarized in Table I.

TABLE I — AVERAGE FOOD CONSUMPTION, EXPERIMENT I

Days after irradiation	Group I (grams)	Group II (grams)	Group III (grams)	Group IV (grams)
1	7	6	7	20
2	3	2	6	9
3	2	1	4	11
4-6	4.3	8	16.3	8.3
7-11	15.8	15.2	16.6	14.4
12-31	18.8	19.6	18	19.7

The rats were observed for 30 days. At the end of this time, they seemed completely normal. Because all but one animal survived the irradiation, a higher dosage was used in Experiment II.

Experiment II

Methods

Sixteen male Sprague-Dawley rats, weighing approximately 200 grams, were given 1000 r total body irradiation at 39.1 r per minute. The source was a Co-60 therapy machine. Involved factors were as before, except that the irradiation time was 25.5 minutes.

Two groups of eight individually-caged rats were established. Both groups were offered approximately 25 gm. per day of ground Purina dog chow. In addition, Group I was force-fed 2 ml. per day of a fat emulsion identical to that of Experiment I.

Force-feeding again began the morning following irradiation, and was continued for as long as six days post-irradiation. Chow intake was measured daily. Body weights were recorded on the day of irradiation and every three days following irradiation. Leucocyte counts and hematocrits were taken pre-irradiationally and the 2nd, 7th, and 14th days post-irradiationally.

Results

Of the force-fed group, 62.5% died by the 12th day, whereas only 12.5% of their controls had died by this time. Only one rat, a control, survived the exposure. The experiment was discontinued after 33 days. Little difference in weight loss was shown by the two groups. The emulsion had no influence on the hematological findings. Food intake dropped more severely for the force-fed rats, and remained low for a longer period of time. (Table II)

TABLE II — AVERAGE FOOD CONSUMPTION, EXPERIMENT II

Days after irradiation	Group I (force-fed) (grams)	Group II (controls) (grams)
1	9	7
2	2	6
3-4	0	1
5	3	8
6	5	14
7-11	11.4	16
12-14	11	6

Experiment III

Methods

Twelve male Sprague-Dawley rats, weighing 200 grams, were x-irradiated with 800 r total body irradiation. (The LD/50/30 days is 680 r). Involved factors were as follows:

1. The irradiation was delivered at 200 kv. using filters of ½ mm. Cu and 1 mm. Al.
2. Irradiation dosage rate was 36.6 r per minute.
3. Tube to target distance was 53 cm.
4. Four rats were irradiated at a time.
5. Rice was used to give uniform backscattering.

Two groups were established as in Experiment II. Six rats were force-fed 2 ml. per day of emulsion; six served as controls. All animals were allowed ground Purina dog chow *ad libitum*. Force-feeding was begun the day following irradiation and continued until death.

Body weights were recorded every two days. Leucocyte counts and hematocrits were taken on the 2nd and 6th days post-irradiation. Food intake was measured each day.

Results

The death rate finding is significant. 66 2/3% of the force-fed rats died before any of the controls. (Table III).

TABLE III, TABLE OF DEATHS, EXPERIMENT III

Days of Death, Post-Irradiation	Group I (force-fed) Number of Rats	Group II (Controls) Number of Rats
4	3	0
5	1	0
6	1	2
7	0	1
8	0	1
9	1	1

Weight loss was more severe in the tube-fed animals than in the control group. After four days, the former had lost an average of 63 gm. whereas the latter had lost only 45 gm.

Hematological findings showed no significant differences.

Food intake dropped more quickly and remained low longer for the force-fed animals than for their controls. The consumption dropped to zero for three days post-irradiationally for the former. It dropped to near zero also in the controls but ran to 4 gm. by the third day.

DISCUSSION

It was originally believed that weight loss post-irradiationally is due to tissue destruction. However, Edelmann (4) suggested that this loss is caused entirely by decreased food intake. In my experiments, there was no decrease in weight loss in animals receiving fat emulsion by stomach tube when compared to non-force-fed animals.

These experiments confirm Willie W. Smith's findings (2) that force-feeding is detrimental to irradiated rats. The survival time for the tube-fed animals proved much shorter than those of the controls. Food intake was restricted more sharply and for longer periods of time in the force-fed animals.

Diarrhea developed more quickly and was more severe for the tube-fed rats. Autopsy finds in Experiments II and III included distended stomachs and intestines. Distension was greater in the force-fed rats. Hemorrhage was noted often in the intestine and in the stomach of both experimental and control animals.

D. E. Smith found (4) that food is retained in the stomach for 4 or 5 days post-irradiation. In my experiments, little emulsion was found in the stomach upon death. The distension was due either to gas, blood, or chow.

SUMMARY

Force-feeding of a fat emulsion to rats irradiated with 750 r or 1000 r (Co-60) and with 800 r (x-ray machine) was studied. Such feeding did not reduce anemia, decrease in leucocyte counts, or body weight losses.

With 1000 r Cobalt irradiation and with 800 r x-irradiation, the tube fed animals showed less food consumption, more acute diarrhea, greater stomach distensions, and shorter survival times than their controls. It seems conclusive that force-feeding of a fat emulsion immediately following irradiation is detrimental.

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A STUDY OF CHEROKEE MEDICINE

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In this modern world of ours, we seldom stop our routine lives to think about our predecessors—the Indians. I decided to make my project on the Cherokees and their medicine. They depended upon good health as much as we do today. Although the Cherokees didn't contribute anything to our modern medicine, theirs was one of the most interesting in all history and showed primitive man's struggle for existence.

The Indian equivalent of our doctor was the medicine man. He had charge of the following practices which I will discuss later:

Diagnosing the Illness

The Cherokees recognized 230 diseases. The medicine man's first step in diagnosis was to uncover the seat of the pain. Then he matched the pain with any dreams, omens, or broken taboos