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A STUDY OF THE X-IRRADIATION PROTECTION AFFORDED BY COBALT*

*Subtask under Effects of Irradiation, AMRL Project No. 6-59-08-013, Subtask, Early Effects of Ionizing Radiation.

MEDICAL RESEARCH AND DEVELOPMENT BOARD
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A STUDY OF THE X-IRRADIATION PROTECTION AFFORDED BY COBALT*

by

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from

Army Medical Research Laboratory
Fort Knox, Kentucky
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ABSTRACT

A STUDY OF THE X-IRRADIATION PROTECTION AFFORDED BY COBALT

OBJECT

Since cobalt produces anoxia and polycythemia and is believed to interfere with sulfhydryl groups necessary for cellular activity, it was of interest to determine the influence of cobalt on irradiation effects.

RESULTS AND CONCLUSIONS

White mice kept for several days (5 to 8 days) before irradiation (720 r) and several days (about 15) after irradiation on a cobalt diet (3 to 4 mgm. of cobalt per day) showed a significant increase in resistance to total body irradiation as compared with mice kept on a Purina stock diet. Tentatively it is concluded that the changes produced in the organism after administering small amounts of cobalt (anoxia, polycythemia) are responsible for the effect. A comparison with currently discussed irradiation mechanisms such as oxygen tension, role of sulfhydryl compounds and enzymes, and blood and blood forming system, unveils close parallelisms.

RECOMMENDATIONS

The observed effect should be investigated intensively with different cobalt compounds, different concentrations, different administering times and cobalt in combination with other physical and chemical factors.

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I. INTRODUCTION

Anoxia produces polycythemia (1, 2, 3), anoxia protects against irradiation damage (4, 5), and cobalt interferes with cellular respiration and produces polycythemia (6, 7, 8). Does cobalt protect against irradiation damage?

Animals suffering from loss of appetite, anemia and loss in body weight (signs similar to those of radiation sickness) can be cured with cobalt (9). Can cobalt cure actual irradiation damage?

The role of anoxia in irradiation protection is under intense study (4, 10) and the importance of blood and the blood-forming system in counteracting irradiation damage is under discussion. The platelets have been investigated by Cronkite (11), lymphocytes and lymphatic tissue by Jacobson (12, 13), and the blood forming system by Cronkite (14), Jacobson (15), and Lorenz (16, 17).

With these facts in mind investigations on the influence of cobalt in total body irradiation effects were undertaken.

II. EXPERIMENTAL

A. Methods and Procedures

Approximately 300 female Swiss albino mice (24-26 gm.) were used in these experiments. They were divided into four groups for each experiment:

Group 1 - Purina stock chow diet.
Group 2 - Cobalt diet.
Group 3 - Purina stock diet plus irradiation.
Group 4 - Cobalt diet plus irradiation.

The cobalt diet was prepared by immersing the Purina chow pellets in a 2% cobalt chloride solution ($CoCl_2 + 6\ H_2O$) for a period of two minutes and then allowing them to dry. The average amount of cobalt per gram of pellet was about 1.0 mgm. Thus each mouse, eating 3 to 4 grams per day, received approximately 3 to 4 mgm of cobalt per day. The mice were kept on this diet five and eight days before irradiation and for about 15 days after irradiation. Water was given ad lib.

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The mice were irradiated in groups of 10, each group consisting of 5 mice on Purina chow and 5 mice on the cobalt diet. The irradiations were done with a Kelley-Koett deep therapy x-ray unit, operated at 200 Kv, 6 ma, 1 mm Al plus 0.5 mm Cu, 30 cm target distance, 40 r/min in air; a total of 720 r. The mice were observed for 30 days after irradiation and the mortality rate was recorded every 24 hours.

B. Results

The results obtained with animals receiving cobalt food for five and eight days prior to irradiation are presented in Figures 1 and 2.

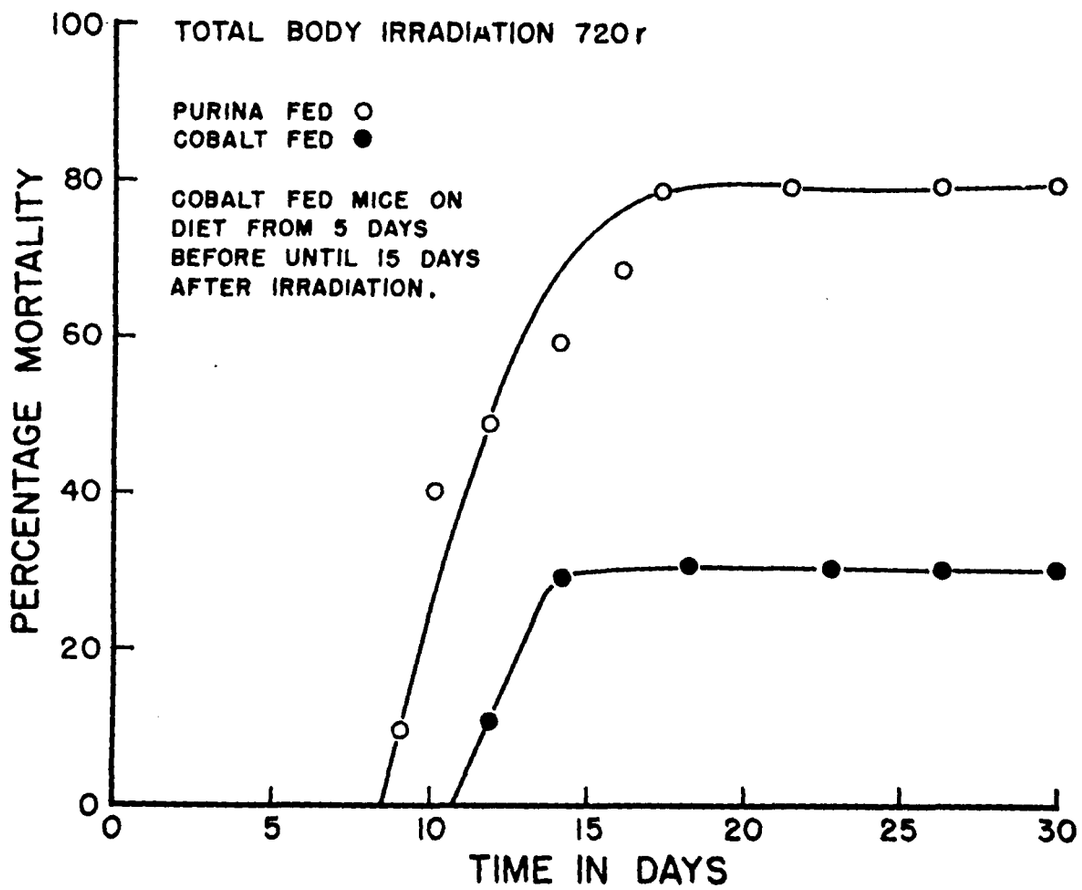

FIG. 1 MORTALITY RATES

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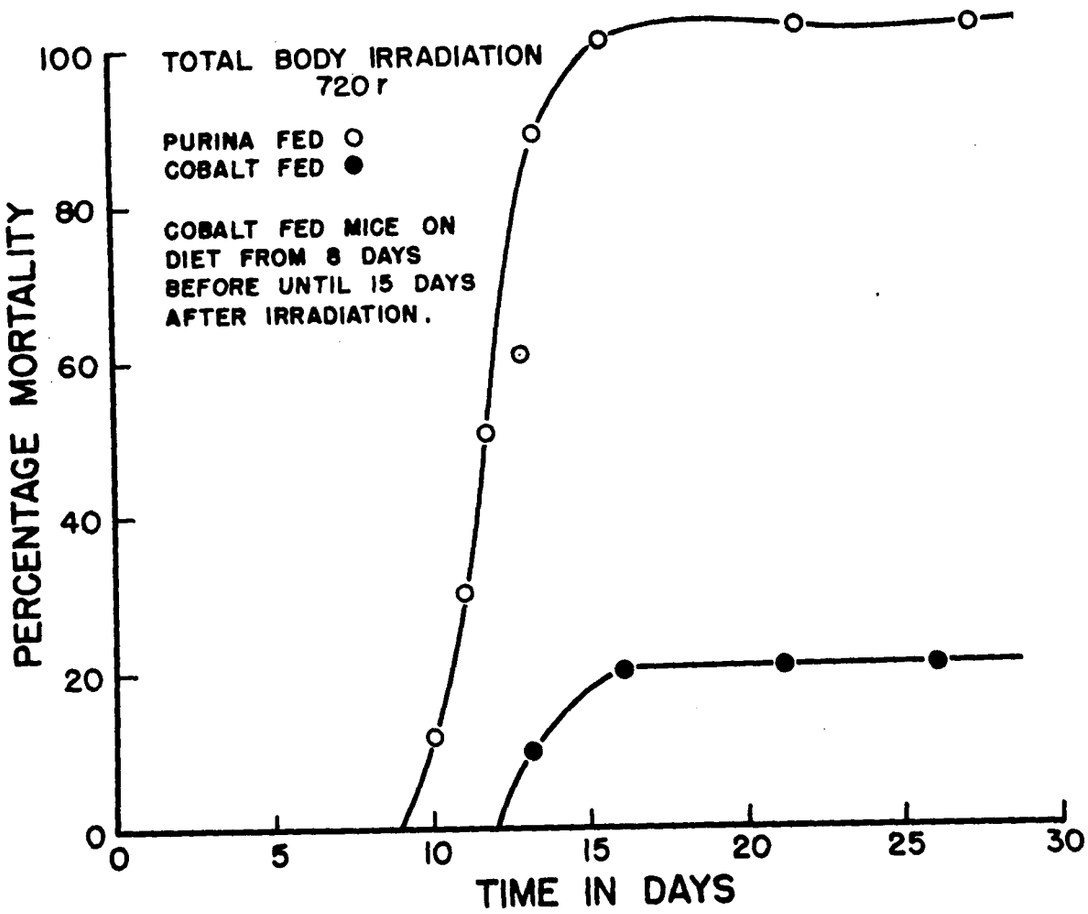

FIG. 2 MORTALITY RATES

The animals kept on cobalt diet before irradiation show in both cases a significant increase in their resistance against irradiation in comparison to the irradiated groups on Purina chow only.

The general appearance of the cobalt fed irradiated animals was quite similar to that of the non-irradiated animals. They exhibited smooth fur and normal vitality while the irradiated animals on normal food and the few animals that died in the cobalt fed irradiated group showed all the signs of heavy irradiation damage.

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III. DISCUSSION

The protective effect exhibited by cobalt lends itself to discussion and comparison with present irradiation protection investigations.

The oxygen deficiency increases the resistance against irradiation damage. Compounds such as cysteine and glutathione counteract irradiation effects on sulfhydryl enzymes. The proper support of the hematopoietic system stimulates and speeds recovery.

In cobalt administration experiments, similar processes are going on. According to Orten and Barron cobalt interferes with cellular respiration and produces anoxia. According to Burk, et al., cobalt may block sulfhydryl groups and perhaps other groups necessary for tissue metabolism. According to Orten, cobalt produces a strong polycythemia, indicating an active stimulus to the hematopoietic system.

Which of these mechanisms is decisive in the observed cobalt protection effect? It may be that not one mechanism alone but all three together, working in a functional correlation, produce the effect. The parallelism is so close and the possibilities to obtain more information on certain phases of the protection mechanics are so obvious that more investigations are worthwhile.

IV. CONCLUSIONS

The above reported experiments indicate that cobalt given orally several days before and after irradiation increases the resistance of white mice against total body irradiation. The way in which cobalt produces this protection may be closely related to presently discussed protection measures such as anoxia, the blocking of sulfhydryl enzyme activity and the support of the hematopoietic system.

V. RECOMMENDATIONS

To evaluate all possibilities offered by cobalt for protection against irradiation damage the following experiments should be performed:

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1. Administration of cobalt in different chemical compounds; in modified concentrations; in various methods of application; and at different time intervals before and after irradiation.

2. Irradiations with different kinds of ionizing radiations, and different doses.

3. Hematopoietic studies with different tissues, particularly blood.

4. Early irradiation effect studies on the cellular level.

5. Investigations of cobalt in combination with other physical and chemical factors.

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