

SOME ASPECTS
OF
INTERNAL IRRADIATION

Some Aspects of INTERNAL IRRADIATION

*Proceedings of a Symposium held at
The Homestead, Heber, Utah, 8-11 May 1961*

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PREFACE

MOST of the symposia on effects of irradiation have been concerned primarily with the effects of external radiation, particularly X-irradiation. There are few reviews concerning the pathological changes induced by internal irradiation. The papers presented in this volume are a written record of a symposium, *Some Aspects of Internal Irradiation*, which was held at Heber, Utah, May 8-11, 1961.

The aim of this symposium was to bring together some of the individuals who have been interested for a long period of time in the pathological effects of internal emitters. The participants presented original data and took the opportunity to discuss the interrelationships of several aspects of the unique problems of internally deposited radionuclides. This discussion has been edited by both the discussants and the editors.

Certain of the invited participants presented material which aimed at the fundamental mechanisms by which irradiation might induce malignancy. Two indirect mechanisms were considered. One was concerned with the influence of irradiation on endocrine-mediated carcinogenesis and the other was the interrelationship between radiation and viral carcinogenesis.

One of the basic differences between external and internal irradiation is the duration of the radiation and the range of the particles emitted. Internally deposited radionuclides may have low penetrating radiation, as in the case of alpha particles, but, due to the biological circumstances involved, may expose tissue for a long period due to the long half-life of the radionuclide. Each, then, of the internally deposited radionuclides has its peculiar radiation and metabolic characteristics (absorption, fate and excretion) as an element in a given biological system. Therefore, the radiation dose delivered cannot be considered as a purely physical problem, but the particular biological system must also be considered. As a corollary to this unique situation, the pathological effects of such internal deposition depend, again, on the location of the radionuclide. This, in turn, is dependent upon the mechanisms by which the element is metabolized. It is impossible to determine dose/response relationship of internally deposited radionuclides without considering the unique biological circumstances which occur in their metabolism. The rates at which internally deposited radionuclides are excreted may change with variations in the internal environment. These variations may occur as a re-

sult of adaptation to the external environment. Therefore, dose/response relationships for any particular end point measured may change, due to the imposition of a variety of stressful circumstances.

In addition to the problems of metabolism and of dosimetry, a variety of pathological endpoints are considered. A dose/response relationship is observed for many hematological and biochemical alterations, bone pathology, alterations in the central nervous system and eyes, and also to the general overall change in rate of the aging process. It should be noted in relation to these endpoints that a lethal dose is actually due to the sum of several different pathological events which lead to death. This is different for radiation from the concept of toxicity where it applies to a single unique effect, e.g. a toxin or chemical poison. Dose response should be related, then, to the extent of a particular pathological event rather than to lethality in general. This emphasizes the fact that pathological changes vary in degree of severity and reversibility and each is related to a localized dose in the case of internal emitters.

Finally, some indirect mechanisms by which pathological changes of a wide variety may be induced are also discussed by several authors. For example, the production of indirect pathological changes could occur through the alteration in the minute vasculature of various organs and tissues. Therefore, a variety of radiation effects may be manifested through this indirect mechanism. The possibility that spontaneous fracturing, due to some internally deposited radionuclides such as radium, may be due to loss of bone vasculature is also considered by one of the authors. An indirect effect on certain pathological changes may also be related to the importance of the role played by radiation in altering hormonal balance. This altered hormonal balance may influence carcinogenesis and also a variety of other biochemical, hematological and structural changes in tissues and organs.

Those of us in the Radiobiology Division of the Department of Anatomy, University of Utah College of Medicine, wish particularly to thank all the participants for their scientific contributions, and I wish to thank the senior staff of the Radiobiology Division who not only presented their work, but also played an important part in the organization of the symposium. In addition, we wish to thank those who helped plan the symposium, particularly Mrs. Anne Clarke, who was the executive secretary of the symposium and editorial board. Charlotte Emmons, Garth Westenskow and David Taysum are due thanks for recording the discussion and the individual papers. Secretarial help was provided by Jo Anne Clayton, Mary Lou Horsley, and Rodney L. Jones. Finally, the editors deserve

the thanks of all participants for reviewing the manuscripts as well as the discussion. The chairmen of the various sessions at the symposium were vital to the success of the symposium and their contribution is recognized by all. Finally, we wish to acknowledge the aid of the Office of Special Services of the Atomic Energy Commission for financial support of the symposium.

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PART I

EFFECTS OF INTERNAL IRRADIATION IN THE DOG

