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Isotopes In Medicine: Introduction

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ISOTOPES IN MEDICINE

INTRODUCTION*

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The electrifying news of the explosion of the first atomic bomb in Japan shocked the world, to which the term "splitting the atom" had previously indicated only a remote possibility. Sixty years earlier the world of physics was similarly astounded by Roentgen's discovery of x-rays, which was followed by Becquerel's recognition of natural radioactivity and the isolation of radium by the Curies. The modern production of artificial radioactive materials is a lineal descendant of these earlier discoveries.

The medical application of radioactive isotopes follows three main lines; (1) diagnosis, (2) therapy, and (3) research, physiologic and biologic. In this brief review we will direct attention to some of the more significant uses to which isotopes have been put. No attempt will be made to cover the entire subject or to deal with it in detail.

Radioactive iodine (1^{131}) has been of great value as a biologic tracer, since the thyroid concentrates iodine selectively. The isotope has a half-life of 8 days and emits both beta and gamma rays, permitting study of its concentration by surface measurements. This makes possible accurate studies of thyroid function in benign and malignant states. In cases of thyroid carcinoma whose metastases concentrate 1^{131}, a potential therapeutic effect enters into consideration, although the possibility of damage to the hematopoietic system and other structures leave this question to be decided by future research.

Radioactive phosphorus (P^{32}) has a half-life of 14.3 days and emits beta radiation. Its high concentration in bone and bone marrow, liver, spleen, and lymph nodes, and in the nuclei of actively multiplying cells, has prompted its use in the detection of soft tissue and osseous metastases and in determinations of the activity of bone growth, especially in the epiphysis. The uptake of this isotope by both erythrocytes and leucocytes make it a therapeutic agent of value in certain blood dyscrasias.

Radioactive sodium (Na^{24}) has the disadvantage of a short half-life of 15 hours — which makes it difficult to obtain and use, as it cannot be stored. It is valuable, however, in biologic and clinical studies. It has been used in the determination of extracellular fluid and of circulation time and to demonstrate impairment of peripheral circulation.

The therapeutic possibilities of radioisotopes are intriguing and have been widely investigated. 1^{131}, because of its high uptake in cases of hyperthyroidism, has seemed to be particularly well suited to the treatment of that condition. A study of the various reports in the literature indicates a wide variety of opinion on the subject. There is no doubt of the effectiveness of this isotope in producing remissions of the disease. The difficulties lie in the standardization of dosage and the amount of study necessary in the pretherapeutic stage. Fear of a possible carcinogenic effect has deterred

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some. The possibly adverse effect on the hematopoietic system has caused others to voice a word of caution. Administration of I^{131} has also been used to reduce thyroid function in order to lessen the work load on the heart.

Radioactive phosphorus, has been of considerable value, therapeutically, in controlling polycythemia vera and is widely used for this purpose. Leukemia has developed in some of these treated cases, but since it is known to develop also in the absence of such treatment P^{32} cannot be accepted without qualification as the cause. In some of the chronic leukemias P^{32} has been an adjunct in treatment. It has been found, however, to be of more value in chronic myelogenous leukemia than in the chronic lymphatic type. In some cases the enlarged spleen has not regressed satisfactorily. Acute leukemias have not reacted favorably to radioactive phosphorus; Hodgkin's disease has shown only slight improvement, but in lymphosarcoma evidence of regression has sometimes persisted for several months. Recently the combination of radioactive phosphorus and oreton have shown favorable results in the control of metastatic bone lesions from cancer of the breast.

Radioactive gold, which has a half-life of 2.7 days, has several interesting therapeutic applications. In cases of metastatic carcinoma of the abdominal and pleural cavities direct injections of colloidal radiogold has produced encouraging palliative results, in the form of marked decrease in fluid formation and clinical improvement. in cases of cervical carcinoma radiogold injected into the parametria has been shown to permeate along the lymphatics, with destructive effects. This may prove to be of future importance, Radiogold is also used as a research tool to follow lymphatic drainage routes. Seeds of this isotope do not require removal because of their short half-life.

Cobalt 60, which has a half-life of 5.3 years, has taken a prominent place in radiotherapy. The radiation thus produced is equivalent to 3-million-volt radiation and is useful in the treatment of deep-seated malignant tumors. Cobalt is also valuable in the form of needles and removable seeds.

$Cesium^{137}$ is a waste fission product from nuclear reactors, and has a half-life of 37 years. The gamma radiation is about equal of that of one-million-volt radiation. This isotope may soon be generally available.

$Strontium^{90}$ surface applicators have been found valuable in superficial lesions of the cornea and conjunctiva. A number of other isotopes have had limited usage, but space does not permit mention of the entire list. Intracavitary therapy with some sort of plastic bag containing various isotopes has been found useful in superficial mucosal lesions.

The discovery of artificially produced radioactive isotopes has produced a tremendous impact on the medical world and has provided tools for research along lines previously unthought of. The great hope for a constitutional cure of cancer has, however, not been realized. Discovery of substances which would remain localized in the tumor without delivering generalized radiation would greatly aid in this problem, but this is still an elusive dream. Cobalt 60 and $cesium^{137}$ are excellent adjuncts to our therapeutic armamentarium for external irradiation, just as radiogold and radioiodine are valuable for internal irradiation. The first chapter of this fascinating subject has been written in the past decade. The results of clinical and research work in the coming decades will determine the contents of succeeding chapters.