ISOTOPES IN MEDICAL DIAGNOSIS

NEW TECHNIQUES REVIEWED AT VIENNA SYMPOSIUM

The medical uses of radioisotopes cover diagnosis and therapy as well as clinical research. The therapeutic uses are relatively straightforward, because they are based primarily on the destructive effect of a large radiation dose on body cells. Fortunately, malignant cells are more sensitive to radiation than normal ones. Radioisotopes thus become a useful tool in attacking malignant growths in the body. A special advantage in their use is that certain elements have a kind of "affinity" for certain organs of the body: for example, iodine for the thyroid or phosphorus for bone. Radioisotopes of such elements can be introduced into the body for effecting strong localised radiation upon cancerous growths in the particular organs in which these substances concentrate. In addition, isotopes can be used effectively to reduce hyperfunctioning tissue to its normal activity, as is done in the therapy of hyperthyroidism. A further therapeutic use of radioisotopes consists of forming large well-shielded radiation sources to direct a beam of radiation from outside the body towards a tumour in fundamentally the same way as X-rays are used for radiotherapy.

The diagnostic uses are more varied and complex, and at the same time constitute a much more significant progress in medicine than the therapeutic applications. One of the more simple uses is to introduce a radioisotope into the body and then watch its course through the various stages of its metabolism by measuring its uptake in certain organs of the body or its blood levels or its rates of excretion. The course and nature of the metabolism often helps in determining the existence of disease in the body, as well as its location and character. Radioiodine, for example, is used extensively in the investigation of thyroid disorders. The function of the thyroid gland can be closely followed by observing the fate of a small dose of radioiodine administered to the patient; excessive uptake by the thyroid and high blood levels indicate hyperthyroidism, while uptake below a certain level is found in hypothyroidism. Similarly, radioiron can be used in the investigation of diseases affecting the bone marrow or spleen, radiocalcium in the diagnosis of bone cancer and radiosodium and radiopotassium in the study of disorders of the heart and the kidneys.

Visual Observation

Indeed, even simple tracing with radioisotopes is a valuable method in the investigation of an amazing variety of diseases. Even a study of the movement of a radioisotope or a "labelled" compound from one place to another inside the body yields a great deal of significant information about the state of the tissues through which it passes. But such a study does not tell us anything about the shape or size of an organ inside the body that we may wish to investigate with precision and in detail, and it is often necessary to know the size and shape of an organ to determine its exact condition. This can be done with the help of some specialized equipment which not only detects the radiations from a radioactive substance inside the body, but also produces a two-dimensional visual image of the size and functional condition of tissue that absorbs this substance. This is known as medical radioisotope scanning, aimed at determining the distribution of a radioisotope within an organ which specifically concentrates a radioisotope.

Scanning techniques can be fruitfully used in a study of thyroid disorders, in locating brain tumours, in investigating malignant growths in the liver and in other fields of diagnosis. With these techniques, it is, for example, possible to ascertain the function of nodules in the thyroid gland or to observe the effects of radiation therapy on the size and shape of the thyroid gland. Similarly, scanning techniques may be used to study the size and location of brain tumours. Such investigation has frequently revealed tumours which remained undetected by normal radiological methods.

Problems of Technique

Methods of scanning are, however, exceedingly complex, and although a variety of equipment is now available for the automatic determination of the distribution of a radioisotope in an organ, experience of their use is still limited. To facilitate an adequate exchange of views and a pooling of experience in this field, the International Atomic Energy Agency and the World Health Organization recently arranged a seminar to discuss the techniques and results of scanning. The meeting took place in Vienna for three days from 25 February. Leading experts from different countries presented introductory papers and led the discussions that followed. A wide field was covered and much information was made available that would be of value to doctors and medical physicists planning to adopt these techniques for use in their own clinical isotope laboratories.

The papers presented at the symposium dealt both with the technical problems connected with the devising and handling of scanning equipment and with the

experience so far gained in the study of specific disorders. A major technical problem relates to what is known as collimation (shielding in such a way as to achieve uni-directional sensitivity of the counter). Problems of collimation were discussed by Dr. Hirotake Kakehi (Japan), while Dr. G. L. Brownell (USA) compared the sensitivity patterns of various collimating systems and derived a general theory of optimum isotope concentrations. Dr. M. A. Bender and Dr. M. Blau (USA) outlined the essential requirements for obtaining satisfactory visualization by a scanner. Dr. H. E. Johns (Canada) and Dr. J. F. Cederlund (Sweden) analyzed the basic principles of scintillation counting, well-known in the detection of radiations, and Dr. H. O. Anger and Dr. D. J. Rosenthal (USA) presented a paper on the scintillation camera, one of the most interesting electronic developments of recent years.

Study of Specific Disorders

Three papers were devoted to the study of liver disorders by isotope scanning. Dr. Bender and Dr. Blau described methods of detecting liver tumours with the help of radioiodine-labelled rose bengal, a dye which localizes in normally functioning liver tissue, but is not concentrated in defined lesions such as cysts, which appear on the scans as blank spots. Three experts from Italy, Dr. L. Donato, Dr. M. F. Becchini and Dr. S. Panichi, reported their experience in the use of radiogold for liver scanning. Dr. Brownell and two other US experts, Dr. S. Aronow and Dr. R. Thors, reviewed their pioneer work on the possibilities of scanning the liver and the pancreas with the help of positron-emitting isotopes.

Dr. H. G. Mehl (Germany) reviewed techniques of measuring the distribution of radioisotopes in deep-lying tissues by detection of "bremsstrahlen" which are the result of interaction between the tissue and the radiation emitted from the isotope. Dr. E. Eric Pochin (UK) described the method of "profile counting" in which the detecting counter is moved progressively along the whole length of the body, and at each position records the radioisotope content of the whole width of the body, but of only a short section of its length.

Two papers were concerned with problems of brain tumour scanning. Dr. W. H. Sweet (USA) reviewed his results with scanning procedures using radioarsenic, while Dr. Thérèse Planiol (France) discussed brain tumour detection by means of radioiodine-labelled albumen. Two other papers were on different aspects of thyroid scanning, which is at present the most widely used application of these new techniques. Dr. Franz K. Bauer (USA) described the value and methods of scanning in thyroid cancer, while Dr. Rudolf Höfer (Austria) and Dr. Herbert Vetter (IAEA) discussed scanning procedures in non-cancerous thyroid disease.

During the discussions, Dr. Keroe (IAEA) demonstrated a new electronic device, the use of which results in a substantial increase of contrast and resolution of the recordings of a scanning machine, and which is the first piece of electronic equipment which has been developed and built in the Agency's own laboratories.

The papers presented and the discussions held at this Seminar, which was attended by some forty scientists from about twenty countries, will be published by the International Atomic Energy Agency jointly with the World Health Organization.

Experts at work during the seminar on medical radioisotope scanning held at the Hofburg, Vienna, 25 - 27 February. Thirty-eight scientists from twenty-two countries attended. The meeting was sponsored jointly by IAEA and WHO. Lt. to rt.; front row: H. Johns (Canada), R. Höfer (Austria), L. Donato (Italy), G. Brownell (USA), M. Bender (USA), and F. Bauer (USA)