Nuclear Medicine

OBJECTIVE: Develop to Its Highest Potential the Application of Nuclear Science to the Diagnosis and Treatment of Human Disease.

The phenomenon of radiation was recognized by early investigators to provide an opportunity for both improved health care and decreased health risk. It was foreseen that radiation provided a unique tool that, through application of the combined skills of scientists from the fields of physics, chemistry, biology, and medicine, could be made available in forms convenient for use by the medical profession for the diagnosis, as well as for the treatment, of human diseases. Nuclear medicine would make it possible to monitor body functions, isolate the causes and extent of diseases, and to treat these with methods never before possible.

Techniques that Aid in Diagnosis

Research programs sponsored by OHER have improved medical science's capacity to diagnose certain human illnesses. The use of radioactive elements that preferentially concentrate in certain body organs and that can be followed with very sensitive radiation detectors acts to make the body's internal organs visible to medical diagnosticians. This combination of selective radioisotopes and special instruments has decreased medical cost and simplified or made more effective some procedures. In general, radionuclides are injected into the circulatory system, the resulting gamma emissions are viewed with radiation detectors, and the detected signals are sent to a computer to be transformed into the images used in making the diagnosis.

The development of radioisotopes and their application to diagnosis, therapy, and monitoring of human health problems were accelerated dramatically by the formation of the AEC in 1947 and the establishment of a formal program to coordinate and expand efforts in this field. Nuclear reactors made it possible to generate enormous quantities of suitable radionuclides that could be incorporated into radiopharmaceuticals at moderate cost. In August 1946 the first reactor-produced isotopes for civilian uses (carbon-14 for cancer research) were shipped from ORNL. At the same time, large quantities of radioiodine were shipped to experimenters and clinicians; and in late 1946 S. M. Seidlin, L. D. Marinelli, and E. O. Shory (*J. American Medical Association*, 1946), announced the first effective treatment of thyroid cancer using iodine-130 and iodine-131.

Three examples of radionuclides widely used in radiopharmaceuticals are thallium-201, technetium-99m, and gallium-67, whose use has resulted in improved and less costly diagnosis with lower risk to the patient. Other medically important radionuclides include iodine-123, ytterbium-169, xenon-127, and xenon-133.

Thallium-201 for Diagnosis of Heart Disease Thallium-201 ion is a radiopharmaceutical used primarily for detecting cellular damage and reduced blood flow to the heart (ischemia). The thallium ions that have been injected intravenously are taken up by various organs in proportion to the blood supply of the particular organ. Approximately 85 to 90 percent of the radionuclide passing through the heart or its blood vessels is extracted during each pass. Its use for heart imaging is based on the relationship between thallium uptake and blood flow to that region and the integrity of the cells themselves. Therefore, reduced thallium ion in the heart region indicates either reduced blood flow, cell damage, or both.

Thallium scans can be performed immediately after exercise or at rest. The combination of an abnormal exercise image in the presence of a normal resting image indicates reduced blood flow to the heart. An abnormal exercise image that does not differ from the image at rest indicates previous cell damage and scarring. An abnormal exercise image that is more abnormal than one noted at rest indicates both previous cell damage and reduced blood flow.

History Heart imaging with radioactive particles was performed in