On the Multiple-Detector Type Whole Body Counter for Nuclear Medicine

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Whole body counter has originally been used in health physics and it has recently been applied also for nuclear medicine. Most of whole body counter in Japan have adopted the scanning technique with the single or twin large detectors and the 2π technique with plastic scintillators. We planned another type of whole body counter using the stretcher technique with multiple detectors, which may be suitable for measuring the patient's activity independent from its distribution as compared with the another technique. The counter was built in Chiba university hospital, in June 1969.

The length, width, and height of the counter are 220 cm in each inner dimension, and the thickness of the iron wall is 20 cm. Three millimeter lead sheet is lined inside the wall and the inner surface of the wall is covered by the lucite plate. The counter has eight detectors. Each detector is made of 5″ϕX4″ NaI crystal and RCA 8055 phototube. Four detectors are lined above the couch, and four below. The detectors can be moved manually to an optional position along the body axis, and can also be moved up to 12 cm vertically. The shift to the cross direction is limited to 10 or 15 cm from the center of the body axis. The counting system consists of 8 preamplifiers, the signal selecting and mixing circuits, 4 linear amplifiers, and a 200 channel pulse height analyser. Outputs of detectors are mixed to form the optional combination of eight detectors, and the signal then is fed into the pulse height analyser.

We tried to find the optimum arrangement for the positions of 8 detectors, as it should be desired to obtain constant counts while the radioactivity distribution changes in the body of a patient. The counting-rate response of detectors was determined by placing the point sources of ^{60}Co, ^{137}Cs, and ^{133}Ba at the center of water phantom (20 cm deep). The photo peak counting is used. The best arrangement of 8 detectors were thus obtained. First, 8 detectors, were lined in the same distance from the couch, and from each other. Second, the central 4 detectors (2 above and 2 below) were moved about 5 cm away from the couch. Third, the 4 detectors below were moved to the center of the couch. When the point source is moved 7 cm away from the center of the water phantom, the counting-rate response of detectors was higher than the source in the center. The increment of the counting-rate by the shift of the source is rather small with the use of the integral counting technique instead of the photo peak counting.

The integral counting and thus determined arrangement of detectors made the best counting-rate response in the bodies of patients.

The Use of the Whole Body Scanner for Measurements of Retention and Distribution of Radioisotopes in the Body

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The linear scanning has been prevailed as a convenient method for demonstrating the approximate longitudinal distribution of radioisotopes in the whole body from the outside. One dimentional maps of the distribution are obtained by the linear scanning, demonstrating the ni-sufficient information when the activity of each internal organ is concerned.

The area scanning shows two dimentional maps of distribution of radioisotopes deposited in internal organs. The whole body scanning should be a time-consuming procedure, requiring more than two or three hours for a scintigram of whole body when a conventional scanner is used. Such a whole body scintigram should demonstrates an inaccurate map of radioactivity if the distribution of radioisotopes changes fast as compared with the scan.

We have constructed a new whole body scanner of high speed. Using a special mechanical device, two detectors of the scanner can be moved in synchronous with high speed, up to 500 cm/min. The scanner consists of two opposed detectors, each having a 5-inch in diameter by 2-inch thick NaI crystal, and the mechanical dot recording system. This scanner can make a whole body scintigram in less than 10 min with maximum speed. The quantitative measurement of radioactivity deposited in internal organs will be attainable by proper analysis of the scan record, which is made from oopposite sides of the patient. (Cf Journal of Nuclear Medicine Vol 10, Pp. 265-269) The repeats of scan in a short interval bring the useful information about the dynamic changes of distribution of radioisotopes in the body. These procedures using the whole body scanner will make fundamental data required not only in medical tracer study but also in calibulation of exposure dose of radioisotopes and assessment of its hazard.

The bone or bone marrow is one of tissues dispersing in whole body. The whole body scanning has an advantage over a partial one if the systemic diseases of the bone and bone marrow are concerned. The scintigrams of bone and bone marrow are presented and discussed in details.

Whole Body Autoradiography

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Freezing whole body autoradiography (W-B autoradiography) has become very useful tooles for the metabolic studies on drugs and other radioactive materials. However, it is necessary to apply this technique with full knowledge of its advantage and also disadvantage. The major information which will be expected to obtain by this technique is the relative concentration of the isotope in various organs, and it will be expected poor information as to the retention an fraction of isotope in each organ. It should be, therefore, to employ with other supplemental methods.

In generally, W-B autoradiography is considered to be superior to other autoradiographic techniques in its no translocation and releasing of target radioactive materials from the specimen during its preparation, in the possibility of the making considerably large specimen, and in the relative high resolution.

The advantages of this technique from the point of view in whole body distribution studies are as follows; 1) The largest information in quality and quantity which is expected to be obtained from single animal. 2) The relative concentration gradient of the isotope in various organs is clearly demonstrate and be able to distinguish the local distribution in the organ simultaneously. 3) The information of the special istribution for which it is impossible or very difficult to be caught by other techniques such as in the case of intraperitoneal or subcutaneous injection and fetus in utero can exactly demonstrate. 4) The possibility of the checking of the own experimental proceure in view of physico-chemical character of the material and administration method. 5) Expanded application field to the region of radioactive material by the activation autoradiography.

On the other hand, the disadvantage of this methods are as follows; 1) The time consuming procedure in its specimen preparation and long exposure. 2) The difficult identifying of