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Role of Nuclear Medicine in Patient Management

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Nuclear medicine now has a vital role in patient management and has significantly expanded the physicians armamentarium. It provides unique methodology that includes a varied group of radionuclide techniques. Most of these techniques may be characterised as diagnostic screening procedures and as such are singular atraumatic and innocuous means representing some of the most powerful diagnostic tools of modern medicine. The ultimate goal of all the activities for developing new protocols are contributions to patients care by making the facilities available for diagnostic and therapeutic use in nuclear medicine. Nuclear medicine has under-gone tremendous changes in the last 15 years. From a rather esoteric endeavour it has grown into a well defined auxiliary clinical speciality taking its place alongside diagnostic radiology and clinical pathology. It has found official recognition as a medical speciality by the establishment of the American Board of the Nuclear Medicine in 1972 and of the Board of Diagnostic Radiology with Special Competence in Nuclear Medicine in 1974. My main aim of quoting the above abstract is to show the importance of the field (Nuclear Medicine) that is ship-shaping in such a dramatic way that one cannot afford to ignore it. Even in the United States, the total number of nuclear medicine procedures performed on patients has grown by 25% per year for the last several years by far the fastest growth rate of any medical speciality. That is why we are determined to establish Advanced Diagnostic Research and Radioimmunoassary lab. (ADRIA) at this institute and to perform the following procedures as:

(I) BLOOD VOLUME

Blood has two main components. Cells (erythrocytes, leukocytes and platelets) and plasma, which is essentially water containing proteins and innumerable metabolities being transported between tissues. The red cells are by far the most numerous cellular fraction 4.5 to 5 x $10^6/mm^3$ compared to 6 to 8 x 10^3 white cells and 200 x 10^3 platelets. For volume measurements, therefore, white cells and platelets are disregarded.

The technique of blood determination is simple in principle. It is measured by injection of human serum albumin (HSA) prelablled with I^{131} or I^{125}, the latter being preferred because of its longer half life and shelf-life. RBC can be labelled by in vitro incubation with sodium chromate, Cr^{51}, which attaches firmly to the globin chains of the haemoglobin and has desirable physical charachteristics (T½ 36 days, gamma energy 320 kev. [1]

The labelled RBC or proteins are injected intravenously, saving an aliquot for a standard, from which the total amount injected is calculated. After a suitable period for mixing in the circulation (10 minutes in healthy subjects, longer in patients with heart failure or renal disease) an aliquot of blood is withdrawn from another site. The volume desired is then calculated with the "universal dilution formula" which applies to any volumetric determination.

$$V = \frac{Q}{C}$$

Where V is the volume to be measured.
Q is the total tracer quantity injected and
C is the concentration of tracer in the sample.

(II) CELL SURVIVAL STUDIES

The most common and practical method for determining the RBC life span clinically is by labelling with sodium chromate, Cr^{51}, in the same way as is done for red cell volume determination. After re-injection, blood samples are drawn daily, until the apparent T½ of the disappearence curve is reached.

RBC survival studies serve to assess the degree of haemolytic process. These are important in determining the severity of the illness and its response to treatment. Platelet kinetics, on the other hand, are becoming as practical as red cell studies. Because of the much shorter

normal T½ of only 4 or 5 days, cohort labeles like Selenomethionine, Se^{75}, are applicable for this purpose.[2,3]

(III) IRON TURNOVER STUDIES

The procedure of this study plays a pivotal role in red cells formation determination. The ferrokinetic studies can be done by i.v. injection of the tracer Fe^{59} (in the form of ferrous citrate) serial blood samples are obtained, usually 5 to 8 over a period of 2 to 3 hours. From these samples, the plasma iron clearence is plotted on semi-logarithmic paper. It is an exponential function and should follow a straight line. It is shortened in the presence of normal body iron, if erythropoiesis is accelerated as in haemolytic anemia and polycythemia rubra vera, and prolonged if erythropoisiesis is decreased as in aplastic anemia.

(IV) VITAMIN B12 ABSORPTION STUIDES

(IV) VITAMIN B12 ABSORPTION STUIDES (SCHILLING TEST)

In vivo test for absorption of B12 is based on the Cyanocobalamin (with Co^{57}, being central atom) incorporated into B12 by biosynthesis in bacterial cultures. In this test, a quantity (0.5-1.0 uCi) of the labelled vitamin are given by mouth and urine is collected for 24 hours. Normal excretion values should be over 7%. If the test is abnormal, it is repeated with intrinsic factor (hog stomach). If there is significant rise of excretion with the repeated test, the malabsorption is persumably due to lack of intrinsic factor in the diagnosis is pernicious anemia, If there is no rise of urinary excretion with the second test, the reason for malabsorption is due to lack of intrinsic factor, disease of lower small bowel (Sprue, regional enteritis, Whipple's diasease), diverticula or blind loops in the bowl.[4]

(V) GLOMERULAR FILTERATION RATE (GFR) (Quantitative renal function measurements)

A variety of renal radio-pharmaceuticals have been used to measure global, individual and relative kidney function in order to circumvent the standard but invasive, ureteral catheter split-function procedure by use of dimercaptosuccinic acid (DMSA) labelled with technetium (Tc^{99m})[5]

(VI) WBC (LEUKOCYTES)/PLATELETS STUDIES FOR ABCESS LOCALIZATION

In this procedure, the white cells can be labelled with short-lived gamma emitting radio-nuclides and these are very useful in studying the localization of various organs and leukokinetics. Inflammatory lesions usually accumulate white cells. Labelled platelets are also useful in localizing intra-vascular thrombi[6].

(VII) EXTRA-CELLULAR FLUID MEASUREMENT WITH Br^{82}

Br^{82} usually serve to measure extra-cellular fluids. Injection of the labelled drug allows comparison of the volume distribution of the drug in the extra cellular fluid volume.

(VIII) FAT ABSORPTION STUDIES

The most common clinical conditions to which fat absorption tests have been applied are sprue and intestinal wall lesions in which trials of pancreatic enzyme supplements fail to correct steatorrhea. Radio-idinated fats and fatty acids such as triolein I^{131} (oleic acid I^{131} or oleic acid I^{125} are usually used for these studies.

(IX) THROMBUS LOCALIZATION AND INFARCTION

In^{111} labelled platelets and radio-iodinated fibrinogen are used for thrombus localization.

(X) MUEASUREMENT OF INTESTINAL TRANSIT TIME OF CR^{51} LABELLED ILEOSTOMY PATIENTS

The movement of the Cr^{51}-labelled material is studied by using a profile scanning technique with two external moving radiation detectors. The disappearence of Cr^{51} for the stomach region is to be measured and also the arrival in the caecum/colon region.

(XI) ANALYSIS OF GASTRIC EMPTYING

In this test, standard meal is labelled (Technetium-99m sulfur colloid) and imaging techniques are used in gastric emptying studies with the patients standing. These findings are due to the forward movement of the tracers, within the stomach.

(XII) RADIO-IMMUNO ASSAY TECHNIQUES

With this technique, it is possible to quantify a great variety of organic substances by means of competitive protein-binding techniques using radionuclide-labelled substances.[7,8] There is no doubt that this form of assay is

likely to play an ever dominant role in the measurement of biologically important material.

1 THYROID PROFITLE:

1 Total T3
2 Total T4
3 Free T3
4 Free T4
5 T3 uptake
6 TSH (Thyroid Stimulating Hormone)
7 TBG (Thyrobinding Globulin)

2 FERTILITY AND PREGNANCY MONITORING

1 Prolactin
2 FSH (Follicular Stimulating Hormone)
3 LH (Luteinzing Hormone)
4 BhCG (Bhuman Chorionic Gonadotrophins)
5 Testosterone
6 Progesterone
7 AFP (Alpha Feto Proteins)
8 DHEA-SO_4 (Dihydroxy Epianderone Sulphte)
9 Estradiol
10 Estriol

3 HEMATOLOGY

1 Ferritin
2 Folic Acid
3 Vit. B12

4 THERAPEUTIC DRUGS

1 Digoxin
2 Gentamicin
3 Amikacin
4 Tobramicin
5 Netilmicin

5 TUMOR MARKER

6 ADRENAL FUNCTIONS

7 DIABETES RELATED HORMONES

8 **OTHER PEPTIDE HORMONES**

The development of radio immuno assay or competitive binding assay techniques represents one of the most significant technical advances of the decade. The principal advantages are marked increase in sensitivity over bilogical techniques and increased sensitivity and precision. Such assays are simpler and cheaper once reagents are developed than bioassay techniques.

Of the major endocrine glands, the pituitary, adrenals, thyroid, parathyroid, ovaries, testes and pancreas, the thyroid has been the one best studied with radionuclides. In vitro radioimmunonologic tests are available for adrenal, pituitary, parathroid, ovarian and pancreatic hormones and adrenal scanning agents have been developed. With the passage of time, we here at Sheikh Zayed Hospital, Lahore would cerainly like to make this Institute as one of the best referral center in this country is that specialized field.

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