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Nuclear Medicine in India

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ABSTRACT

The regular supply of radiopharmaceuticals and radioimmunoassay kits from BARC has been an important factor in the development of nuclear medicine in India. However, a major stumbling block has been the non-availability of suitable instrumentation systems (especially the computer-assisted gamma camera) at an affordable price. Two recent developments, viz., the creation of the Board of Radioisotope Technology by the Department of Atomic Energy, and the efforts of Electronic Corporation of India Ltd. to design indigenously a gamma camera with a computer attachment, hold promise for the future healthy and rapid growth of nuclear medicine in the country. Training in nuclear medicine at the post-graduate level is gradually picking up.

Nuclear medicine is essentially applied physiology and biochemistry, and provides an orientation,different from those of the anatomist and physiologist. The gamma camera, SPECT and PET enable the study of dynamic metabolic function in health and disease, adding the dimension of functional resolution to spatial and temporal resolutions. Newer developments in tagged monoclonal antibodies hold promise for a better understanding of infectious and inflammatory diseases which are a burden in the developing countries.

1. INTRODUCTION

It gives me great pleasure to write this article for the Brig. Mazumdar Commemoration Issue of the Defence Science Journal. I and Dr. Mazumdar were contemporary post-graduate students at the Hammersmith Hospital, London in 1956-57. Both of us had passed the MRCP examination and were looking for future avenues of service to the country on our return. Radioisotope techniques had just

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then newly arrived in clinical medicine and the Hammersmith Hospital was the first in the world to have a hospital-based cyclotron installed in 1955 (a machine that is still working). The defence department of Govt. of India asked Dr. Maxumdar to get trained in radioisotope techniques, which he accepted rather grudgingly because basically he was a good clinician and enjoyed examining and treating patients rather than dealing with measuring instruments or test tubes in the laboratory. The choice was good for the country because this culminated ultimately in the creation of the Institute of Nuclear Medicine and Allied Sciences. Today it stands as a monument to the memory of Dr. Mazumdar.

2. NEED FOR COLLECTIVE EFFORT

The regular supply of reactor-produced radiopharmaceuticals and radioimmunoassay kits from the Isotope Division of Bhabha Atomic Research Centre (BARC) has been a major factor in the development of nuclear medicine in India. Unfortunately the biggest stumbling block has been the non-availability of suitable instruments at an affordable price. The vision and dynamism of Homi Bhabha and Pandit Jawaharlal Nehru ensured that atleast in the peaceful applications of nuclear energy there was no time lag,whereas in all other areas of science and technology India was lagging behind by twenty to two hundred years. But this vision and dynamism has not been reflected in the field of indigenous manufacture of gamma cameras and computers which are essential for fully exploiting the useful potential of nuclear medicine in India. Two recent developments have been most encouraging in this regard. The Board of Radioisotope Technology (BRIT) was created in 1988 by the Department of Atomic Energy, with the sole purpose of promoting nuclear medicine in the country. BRIT will be able to promote regional centres to extend nuclear medicine services to areas where such facilities do not exist today.

Electronic Corporation of India Ltd. (ECIL) has now been able to make a gamma camera with a 3/8 in. thick, 16 in. diameter crystal with 37 photomultipliers, which is suitable for the entire energy range of gamma emitting radionuclides currently available, and not limited to low energy radionuclides alone, This camera can be used as a 'stand-alone' facility or can be interfaced with a computer (which is also being developed with indigenous know-how), to perform dynamic function studies including nuclear cardiology. The camera including the computer is expected to be priced at Rs. 20 lakhs provided Govt. of India grants customs duty exemption for the imported components, which will eventually be put at 25 per cent of the total cost of the equipment. Since Govt. of India has already granted duty exemption for radionuclides like ^{201}Tl and ^{67}Ga, it should be possible to get similar exemption for gamma camera-computer components.

At present there are over 120 medical colleges and their attached hospitals in India. Nuclear medicine is a subject in the medical curriculum. I have myself contributed chapters on nuclear medicine and radioimmunoassay (RIA) and nuclear cardiology in the Text Book of Medicine published by the Association of Physicians of India and which is read by over 25,000 post-graduate medical students. With the availability of an affordable gamma camera at about Rs. 10 lakhs, and a

. camera-computer for 20 lakhs, it can now be expected that within the next five years nuclear medicine will become a reality in atleast all medical college hospitals in the country and through them serve millions of needy patients.

An integral part of this whole scheme is the creation of an infrastructure for training engineers and technicians for the maintenance and repair of the said equipment. Adequate storage of appropriate spares and their ready availability is a mandatory requirement and fortunately there is sufficient technical know-how in this country for ECIL to undertake this stupendous task.

3. TRACER PRINCIPLE

The most fundamental principle of nuclear medicine is the tracer principle invented by George Hevesy for which he received the Nobel Prize in 1944. The ability to administer chemical substances with a radioactive tracer and then follow what happens to them within the human body gives us the unique capability of studying and measuring dynamic functions of the various organs of the human body including the brain. By measuring the spatial distribution of the radibtracer at various intervals of time, we can determine ***what*** is occurring within the body with respect to specific physiological or biochemical processes, ***how fast*** and where such processes are occurring. The use of multiple tracers, each measuring a specific body function, adds the concept of functional resolution to spatial and temporal resolution. These three concepts are fundamental to nuclear medicine.

4. PET AND SPECT

Since the nuclear medicine images are based on function (for example, uptake of radioiodine or technetium by the thyroid, radiolabelled phosphate compounds by the bones, hepatobiliary and renal uptake, myocardial perfusion, brain perfusion, etc.), the information -is complementary to that provided by other imaging modalities like radiology, computerised tomography (CT), ultrasonography and MFU. Nuclear medicine is essentially applied physiology and biochemistry and provides an orientation different from that of the anatomist and pathologist.

Nuclear medicine was the first medical imaging science to use computers for data acquisition, processing, display and quantification, which paved the way for CT and digital angiography. The most recent advance in nuclear medicine is the positron emission tomography (PET). We can now look at 'slices of life' to examine the regional chemistry of the living human body including the brain, in health and disease. Slices indicate the steady growth of PET and the single photon emission computed tomography (SPECT) in nuclear medicine. As Henry Wagner, the doyan of world nuclear medicine has aptly put it, if PET is the heart of nuclear medicine today, SPECT is becoming the muscle and bone. Advances made initially by PET chemistry are soon translated into compounds for SPECT. One of the major forces in the advance of nuclear medicine is the development of new radiopharmaceuticals. Since PET is prohibitively expensive, it is fortunate that new SPECT agents are available and within reach of Indian nuclear medicine experts. We already have now three major SPECT brain agents—^{123}I iodoamphetamine (IMP), ^{99m}Tc

hexamethylene-propylene amine oxime (HMPAO) and ^{99m}Tc ethyl cysteine dimer (ECD). We also have three SPECT cardiac agents—^{99m}Tc isonitrile compounds, ^{99m}Tc boronated agents, and ^{111}In-labelled anti-myosin. SPECT improves the imaging of labelled monoclonal antibodies in the detection of colorectal cancer, malignant lymphoma, ovaries and lung cancer.

5. INFECTION AND INFLAMMATION

India and the developing world have the greatest burden of infectious and inflammatory disorders. ^{67}Ga has been a useful general purpose 'search agent' for the detection and follow-up treatment of infectious and malignant disorders. In the 1990s other alternative approaches are going to be available to us especially those connected with ^{99m}Tc which is readily available to us in India. ^{99m}Tc-labelled AHGA (anti-human granulocyte antibody) and ^{99m}Tc-labelled polyclonal human *IgG* are promising new developments.

Since *IgG* is going to be available as a kit which is much easier and quicker to prepare than the separation and labelling of leucocytes, this approach is going to be the preferred one for us in India for the diagnosis and follow-up of infectious or inflammatory disorders. In principle it would now be possible to address the clinical question; where is the septic focus?, by using ^{99m}Tc-labelled polyclonal human *IgG*, and then proceed further with the next question; *What* is the offending agent?, by using specific monoclonal *IgG* against the suspect---say pseudomonas, Klebsiella, Candida, etc.

6. THE FUTURE OF NUCLEAR MEDICINE

Today's research will become tomorow's practice, just as yesterday's research is today's practice. We will continue to have new brain tracers, new heart tracers, uniquely useful studies that can be performed with no other modality, and cost-effective studies. Medicine in general has accepted the orientation of nuclear medicine towards function and chemistry.

The nuclear medicine community in India has great challenges and great opportunities. Whoever assumes responsibility in nuclear medicine has to maintain his or her competence at a high level, and ensure rigorous quality control. There is no place for mediocrity or slopiness in a field which is characterised by a confluence of several basic disciplines, and which is using highly sophisticated and highly demanding technology (like SPECT) and which is working at the advancing edge of medical knowledge.