NUCLEAR MEDICINE- A NEW DISCIPLINE

By Herbert Vetter

Whether or not NUCLEAR MEDICINE is a discipline in its own right has been a topic of lively discussion among scientists for some time. The following text is a slightly abridged rendering of a paper on this subject presented by Dr. Herbert Vetter during the Second National Congress of Nuclear Medicine at Tel Aviv, December 1965. Dr. Vetter is Head of the Medical Section and Assistant Director, Division of Isotopes, Department of Research and Isotopes, IAEA.

Before discussing the present status and likely future of nuclear medicine in the world, one must first define the term. It seems better not to consider - as some do - nuclear medicine as including the science of radiation effects on man, particularly those likely to result from nuclear warfare. This discipline I would call radiation medicine or human radiobiology but not nuclear medicine. Nor do I think that the use of isotopes in fundamental medical research is a part of nuclear medicine; the reasons for this separation will appear later. What remains then, is nuclear medicine as the science of the use of radioisotopes for diagnosis and treatment of disease and in clinical research work.

In this discussion, however, a further narrowing of the subject is required. The use for cancer treatment of cobalt-60 and caesium-137 in teletherapy machines and of radioactive gold as seeds, yttrium-90 as pellets or radiotantalum as wires for implantation into tumours are, of course, also therapeutic applications of radioisotopes. In several textbooks and bibliographies references to this type of work are considered as falling within the field of nuclear medicine. However, there is no doubt that radiotherapy with solid or sealed radioisotopes will remain in the hands of the radiotherapy specialist where it properly belongs, and need not be discussed here any further.

Here then is a critical point in the discussion. Is nuclear medicine a speciality in its own right, is there such an animal as a specialist in nuclear medicine? Many people, particularly in England and the United States, deny this vehemently. They argue that radioisotopes are just a tool, like the microscope, and that they should be used by the clinical specialist, e.g. the haematologist, the endocrinologist, etc, along with other tools of his profession. About half a century ago nearly the same argument was brought forward by those who opposed the establishment of radiology as a speciality. Certainly, X-rays are also only a tool - in fact, the analogy to the microscope appears to be more appropriate - but their most efficient and most beneficial use soon required a specialist physician who made radiology his main business. Since then, this development has continued to

a stage where it has become necessary to split radiology even further into radiotherapy and diagnostic radiology.

Which are the arguments that speak in favour of nuclear medicine as a speciality in its own right? First of all, the field continues to expand rapidly – new isotopes and labelled compounds as well as new equipment make possible new applications. Already ten years ago it could be said that there was no medical speciality in which radioisotopes had not found some application. Consequently, the need arose in many hospitals to establish central radioisotope laboratories that would provide services to several hospital departments and clinics. There are, apart from any medical and scientific reasons, a number of economic and administrative considerations which favour this development. Modern counting equipment has become so sophisticated and expensive that only the richest hospitals and universities can afford to have, say, an automatic liquid scintillation counter on each floor – and sometimes several on the same floor – often used only occasionally if a particular research project requires it. Centralizing expensive equipment at one place in the hospital and using it fully results in considerable financial savings. Further, the ever-increasing severity of official radiation protection regulations requires the introduction of increasingly expensive protection measures and, in particular, the establishment of waste disposal facilities which are most economically set up in one place. The centralization of isotope purchases offers further opportunities for saving money. Finally, central record keeping of patients who have received diagnostic or therapeutic doses of radioactivity is becoming a necessity; instances where a patient still retaining some radioisotope from a previous diagnostic test in one department is given another radioisotope test in another department are becoming more frequent. Thus, in all but the richest places the tendency is to centralize the hospital radioisotope service and the man in charge, who devotes his full time to running the service, automatically becomes a specialist in nuclear medicine.

PROFESSIONAL SOCIETIES

Recognition of nuclear medicine as a separate discipline expresses itself also in other ways. There are now a large number of textbooks devoted to this particular subject Several journals in the United States, Germany, Japan, Korea, even two in Italy specialize in nuclear medicine. Excerpta Medica (Amsterdam, Netherlands) produces monthly a separate volume of abstracts and the Gmelin Institute (Frankfurt, Federal Republic of Germany), as well as the Agency, publish lists of references. Several professional societies of nuclear medicine are now in existence in the United States, Italy, Japan, Germany and several Latin American countries with an estimated total membership of over 3000. They hold annual scientific meetings which provide opportunities for the exchange of scientific information as well as for a discussion of problems of professional status and recognition. There are other nuclear medicine meetings such as those organized in Oak Ridge, Tennessee, and by the Agency, and the bi-annual symposia in Bad Gastein, Austria, which by now have gained considerable reputation not only for their scientific quality but also for their informal atmosphere.

Finally, and very significantly, several universities have actually established chairs of nuclear medicine.

There can, therefore, be little doubt that this development will continue, and will ultimately end in the universal recognition of nuclear medicine as a discipline in its own right. Of course, nobody will ever dispute the right of individual specialists to use isotopes for their own purposes, provided they are sufficiently trained. This group of "toolists" includes nearly all those who use radioisotopes in fundamental medical research, and also some clinicians. An extreme case is the accident surgeon who wishes to use one of those new semi-automatic machines to make a rapid assessment of blood volume; he does not have to be a fully-fledged specialist in nuclear medicine. The analogy to the dentist who occasionally takes a picture of a tooth granuloma but need not be a full-time radiologist, is apparent. The question now arises what qualifications we should expect from a specialist in nuclear medicine, and what type of training he should receive.

I do not think that he necessarily has to be a physician; there are several examples which demonstrate that a medical physicist can head a hospital isotope laboratory just as well if not better. Personally, I would prefer to see a physician in charge of a hospital isotope laboratory; he must, however, have a very solid background in physics and mathematics and in France, for example, most of the leading nuclear medicine specialists have degrees in both medicine and physics. He also should have a full understanding of, at least, the principles of radiobiology and radiation protection and should have spent some time in a chemical pathology department. Most important, however, he should understand the pathology, diagnosis and therapy of the various disorders for which he may be asked to provide a particular radioisotope service. Otherwise, his role will soon be reduced to that of a technician, in the same way as a radiologist without a solid clinical background soon becomes a mere radiographer. It follows that his training will be long - indeed several years - and that training courses on medical applications of radioisotopes of a few weeks' duration are at best only a prelude to long-term and high-level training leading to specialization.

Under these circumstances the fierce discussion that raged years ago (and occasionally does so even now) on whether the nuclear medicine specialist should be a radiologist, an internist or a clinician of some other specialization, is nowadays becoming largely academic. Likewise, a newly established group of nuclear medicine specialists should not be incorporated into an existing Society of Radiology or of Internal Medicine but should from the very beginning be set up as a separate body.

PHYSICIAN AND PHYSICIST

A physician in charge of a medical isotope service will always be able to speak on equal terms with his colleagues in other clinical departments; while the responsibility for the patient whom they have sent to him for a particular radioisotope study or diagnostic test will always remain with them, his voice will be heard and his interpretation of the results

of such a study or test will be given proper weight. Once more, the analogy to the relationship between the radiologist and his clinical colleagues is obvious. But however well-trained in physics and mathematics this nuclear medicine specialist may be he will never be able to provide first-rate radioisotope services without a medical physicist at his side. It is, of course, true that there are a number of routine diagnostic radioisotope tests, particularly those involving sample measurement, which can be done without the expert advice of a physicist. Beyond the routine tests, however, this is not always the case. A physician in a well-known hospital was about to publish some sensational new results on bone metabolism which he thought he had obtained with calcium-47, when he was informed that for the last year or so he had made his sample measurement with his single-channel analyser aligned on the scandium-47 peak. His calcium turnover studies were thus, in fact, scandium turnover studies. The need for advice from a physicist is even more apparent in in-vivo measurements and this is true even for such old and established tests as the uptake of radioiodine by the thyroid gland. In the last three years, the Agency has made an extensive survey of techniques of thyroid uptake measurements in about 200 isotope laboratories; the methodology was more satisfactory in laboratories with a medical physicist than in those without one.

With the ever-increasing complexity of techniques and equipment, a medical physicist will in future be even more needed in a hospital radioisotope laboratory than nowadays. This is not universally accepted, and many hospitals and even teaching departments have just about come round to recognizing the need for a clinical chemist and have established a post for him, but are far from accepting the idea that a clinical physicist is needed as well. However, even if there should be the required number of established posts available for hospital physicists, there remains the serious problem of finding the physicists themselves. There are only four countries in the world where hospital physics is a profession of sufficient attraction to young physics graduates: the United Kingdom, Canada, the United States and Sweden. In almost all other countries physicists are drawn into industry, physics research institutes or atomic energy establishments because of better pay and brighter career prospects. The IAEA spends a considerable fraction of its technical assistance funds to alleviate this difficulty.

Another question is of no less importance to nuclear medicine and its future. There is no doubt that the control imposed on the use of radiation and radioisotopes is an outstanding example of the control of a problem before it has become serious. The prevention of radiation hazard to a third party is an accomplishment we should not make light of, but there is now an increasing tendency to extend this control to the first and second party, namely the doctor and his patient. The question is, should we continue to accept this anomalous situation which has no parallel in any other area of medical practice?

RESTRICTIONS ON THE DOCTOR

Obviously the use of radioactive isotopes – because of their, at least theoretical, permanent capacity for causing harm – requires special precau-

tions to prevent injury to the third party, i.e. to those who are using them in the course of their duties as well as to those who may become accidentally contaminated, such as patients in the same ward or members of the family at home when the radioisotope is administered to an ambulatory patient. Thanks to the efforts of the International Commission on Radiological Protection (ICRP) and various intergovernmental organizations such as IAEA, there are now available sufficiently detailed codes of practice and data on maximum permissible concentrations in air and water to ensure that the nuclear medicine specialist is supplied with information relevant to the protection of the occupationally exposed radiation worker as well as the general public. We simply have to follow these rules and regulations to ensure that any third party will not be exposed to risk and there could not be any objection to the establishment of some sort of control apparatus which sees to it that these rules are in fact observed.

What we are discussing here, however, is the question of the desirability or, perhaps, permissibility of the administration of a certain radioisotope or labelled compound, or of a certain quantity of such material by the doctor to his own patient. This question is one that can only, and should only, be answered by the doctor himself. There is surely no difference whatsoever between radioactive compounds and any other compound which the doctor may administer to his patient for diagnostic or therapeutic purposes, except for the rather distant relationship of radioisotopes to the atomic bomb and fall-out from weapon tests with all the associated psychopathological reactions in the minds of the public, including our non-medical colleagues. Even the property which radioisotopes possess of increasing the natural mutation rate, is shared by many non-radioactive drugs, often administered rather indiscriminately.

It is therefore up to the medical profession to set themselves standards of good radioisotope practice and to see to it that those who are guilty of malpractice through neglect or ignorance are called to order. However, has the medical profession sufficient facts available on which to base a sound judgment? The wide variations in opinion throughout the world as to which doses are desirable or permissible indicate that this is not so. There are many countries where standards of good radioisotope practice do not exist at all; there are some countries where the required decisions are made by a hospital committee and may consequently show considerable variations between hospitals, and finally there are a few countries in which governmental regulations are so stringent as to hamper orderly progress of nuclear medicine, and go so far as to deprive patients of the benefits they may derive from diagnostic radioisotope procedures.

What is being done to provide the medical profession with the necessary data on doses resulting from radioisotope procedures? The data assembled by the ICRP are clearly not applicable, since they relate mostly to continuous exposure of radiation workers but give little information on doses resulting from single-shot exposures. The International Commission on Radiation Units and Measurements (ICRU) recognized the urgency of the problem in 1962 and set up two task groups to deal with it. One, on tracer kinetics, has nearly finished its work, which is designed to elaborate the basic framework of generally acceptable definitions, units and

symbols which can be used in internal dose calculations. The second group is concerned with methods of assessment of dose and how these should be used in a standard fashion. ICRU is likely to stop at this point and to leave it to others to employ the recommended methods for the calculation of doses resulting from typical tracer procedures. One of these "others" will be the Agency, which has begun to collate and evaluate the relevant physical and metabolic data, at present widely scattered throughout the literature. It is hoped to produce in due course dose figures for normal adults, for normal children of various ages and perhaps for patients with fairly typical disease conditions.

Diagnosis of brain tumours. Serum albumin, labelled with radioactive iodine and administered intravenously, concentrates mainly in brain lesions, e.g. malignant tumours. A scintillation detector directed at marked positions on a rubber cap enables lesions within the skull to be located. (Photo: CEA France)

The Agency will go no further, however. It will not make recommendations on doses that should be considered permissible or desirable. That judgment is one which only the doctor can and should make, in the light of the individual circumstances and on the basis of a careful comparison of the benefit his patient might derive from the particular radioisotope procedure with the possible risk from the resulting radiation dose.

Finally, one may just touch upon the problem of the clinical routine tests. It is understandable that the clinician and particularly the one who uses radioisotopes as a tool only, wishes to have at his disposal some fool-proof radioisotope test which can be done with cheap equipment in a minimum of time for a maximum number of patients, and which gives a clear yes-or-no answer to a diagnostic question. There are at present only very few radioisotope tests which meet these criteria. There are many more which purport to meet them, and have been quickly introduced into everyday routine without a clear understanding of their underlying physiopathological mechanisms and the source and magnitude of the associated errors. A classical example is the liver function test with the radioiodine-labelled dye Rose Bengal which by now has almost fallen into disrepute. The original technique was crude, several modifications tried to keep the test "simple" and still little is known of the fate of Rose Bengal in the human body under physiological and pathological conditions. Observing the very large number of papers that are at present published on the clinical results of radioisotope renography, for studying kidney functions and searching in vain for basic information on basic metabolic data, for quantitative methods of expressing them and for a discussion of sources of error, one sometimes wonders whether this "test" might not one day also be considered as unreliable and misleading. Before a new clinical radioisotope test is introduced and its routine use is advocated, a very thorough study of its underlying mechanisms ought to be made in each case, using the most modern techniques and the most recent equipment. Only after this is done, should attempts be made to develop a more simple procedure which would better suit the needs of everyday routine.