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MEDICAL RADIATION PHYSICS

Report of a
Joint IAEA/WHO Expert Committee

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JOINT IAEA/WHO EXPERT COMMITTEE ON
MEDICAL RADIATION PHYSICS

Geneva, 12-18 December 1967

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MEDICAL RADIATION PHYSICS

Report of a Joint IAEA/WHO Expert Committee

A Joint IAEA/WHO Expert Committee on Medical Radiation Physics met in Geneva from 12-18 December 1967. Dr P. Dorolle, Deputy Director-General of the World Health Organization, opened the meeting and welcomed the participants on behalf of both organizations.

Dr Dorolle emphasized the growing specialization of medicine and the need for assistance from the natural sciences in the development and use of different methods in diagnosis and therapy. He pointed out the important role of physics in modern medicine, especially in the use of ionizing radiation and radioisotopes in the fields of radiotherapy, diagnostic radiology and nuclear medicine, and stressed the need for the special training of physicists to work in these fields. The provision of trained personnel was of particular importance for those countries in which medical physics services have yet to be developed.

Dr H. M. Parker was elected Chairman, Professor I. G. Lagunova Vice-Chairman, and Dr E. W. Webster Rapporteur.

A list of unpublished documents submitted as working papers to the Committee will be found in the annex on page 19. They review the existing status of medical physics in various countries, give details of training programmes in medical physics, and suggest ways in which the needs for medical physics services might be met.

1. THE PLACE OF MEDICAL RADIATION PHYSICS IN THE HEALTH SERVICES

The Committee considered that medical radiation physics had an important and continuing function in medical care and the health services. The importance of medical radiation physics has already been clearly defined as regards radiotherapy by earlier meetings convened jointly by WHO and IAEA.¹ In addition physics plays an important role in the fields of nuclear

¹ Joint IAEA/WHO Meeting (1963) *Practical methods of assisting radiotherapy centers in less-developed areas*: *Acta Radiol. (Stockh.)*, N.S. 1, 217 & *Brit. J. Radiol.*, 36, 453; Joint IAEA/WHO Meeting (1966) *Planning of radiotherapy facilities*, Geneva, (*Wld Hlth Org. techn. Rep. Ser.*, 328).

medicine, diagnostic radiology, radiation protection, and diverse other medical specialties.

1.1 Medical physics in radiotherapy

Radiation physics plays an essential role in the treatment of all patients by radiation. The activities of the physicist in relation to radiotherapy have been described in detail in the reports of the two joint IAEA/WHO meetings referred to above. He provides a number of services related to the treatment of patients, teaching and research. The physicist is responsible to the radiotherapist and his minimum duties are :

(a) responsibility for all aspects of radiation dosimetry in external beam therapy and brachytherapy;¹

(b) collaboration in treatment planning, and in verification of the accurate execution of the plans ;

(c) responsibility for all physical aspects of radiation protection ;

(d) design of such items of ancillary apparatus as beam-directing devices and supervision of their construction ;

(e) overall supervision of the maintenance of equipment ;

(f) advice on the choice of new radiotherapy equipment and on the physical aspects of the design of buildings.

In addition, an important duty of the physicist is the introduction into the radiotherapy department of new scientific or technical developments.

1.2 Medical physics in nuclear medicine

For the purposes of the present discussion, nuclear medicine may be considered to embrace all applications of radioactive materials in diagnosis or treatment or in medical research, with the exception of the uses of sealed radiation sources in radiotherapy.

The position occupied by nuclear medicine in the administrative structure varies with the country and the medical institution concerned, and it may fall within the competence of various departments. Whatever the local situation, the techniques of nuclear medicine are now so highly developed and the instrumentation so advanced that work in the field should be undertaken only by specially trained personnel with appropriate facilities at their disposal. These considerations call for some degree of centraliza-

¹ IAEA (1967) *Physical aspects of radioisotope brachytherapy*, Vienna (*Techn. Rep. Ser.*, No. 75).

tion of nuclear medicine services within a given area or even within a given institution.

By its nature, nuclear medicine is a collaborative activity involving personnel of several different disciplines. Whilst the ultimate responsibility for interpreting the results of a given diagnostic procedure or prescribing a therapeutic procedure must rest with the physician concerned, the actual operation of a nuclear medicine service may require the participation, direct or indirect, of physicists, chemists, radiation biologists, mathematicians and electronic engineers, all with appropriate special training in nuclear medicine techniques. Technicians are needed in laboratories and clinics for the carrying out of the various procedures and for the care of the instruments used. The provision of adequate facilities for maintenance is of special importance in ensuring an efficient nuclear medicine service.

In the present state of development of nuclear medicine, the role of the medical physicist is of particular importance, though with increasing simplification and automation of techniques his part in the actual execution of routine procedures may be expected to diminish progressively in future years. The duties of the medical physicist in a nuclear medicine service may include supervision of the ordering, dispensing and storage of radioactive materials; the provision, calibration and testing of instruments for radioactivity or radiation measurements; the supervision of such measurements and the analysis of the resulting data; and, finally, the enforcement of rules for the safe handling of radioactive materials and the safe disposal of radioactive wastes.

The extent to which medical physicists are required in a nuclear medicine service depends, of course, on the scope of its activities. A small service undertaking only a limited number of simple routine procedures may be operated by a suitably trained physician with only occasional advice on medical physics problems. If the parent hospital has a radiotherapy department, it will often include a medical physics service, and an appropriately trained medical physicist from this service may be engaged to work part-time with the nuclear medicine service. Alternatively, a medical physicist from a larger nuclear medicine service at another hospital in the same area may similarly be engaged on a part-time basis. If no arrangement of this sort is possible, a physicist on the staff of a local university physics department or atomic energy institution may be employed in a part-time advisory capacity, but such an arrangement should be regarded as a purely interim measure and will rarely be fully satisfactory, especially since a person thus appointed will frequently be unfamiliar with the medical and biological aspects of the procedures to be undertaken. The operation of a large nuclear medicine service undertaking a wide range of procedures without the full-time participation of at least one experienced medical physicist would, however, place a severe burden on both the time and the skills of its medical personnel.

1.3 Medical physics in diagnostic radiology

More attention should be given to the physical aspects of diagnostic radiology.

The physicist can contribute significantly to the initial planning of diagnostic radiology departments, both in relation to protection problems and to the choice of diagnostic equipment. When new X-ray equipment has been installed it is important that measurements be made to ensure its safe working. It is also important for the physicist to ensure that the techniques used in routine practice are standardized and give the best possible results—for example, that the sharpness of pictures obtainable is the maximum and that the photographic and other techniques used are properly standardized. The subsequent routine calibration of diagnostic equipment should also preferably be the responsibility of a qualified physicist.

The physicist is particularly needed in larger departments having special interests, such as enlargement angiography and mammography.

Furthermore, the physicist can often suggest simple modifications of technique that lead to a marked reduction in radiation dose to the patient. This may be of considerable significance, since doses received in diagnostic radiological examinations are known to make an important contribution to the genetically significant dose received by the general population.

The physicist may also contribute to the development, testing and calibration of equipment for which a knowledge of electronics is necessary, since such items as television systems are becoming increasingly common; equipment can be operated satisfactorily only if it is carefully maintained.

Finally, the physicist can play an important role in the teaching activities of a diagnostic radiology department, not only in relation to radiation protection but also in making clear the physical basis of the techniques used. This is important in the education of radiographers, nurses and other personnel. The physicist may also teach the physical principles of diagnostic radiology to his medical colleagues, with a corresponding improved understanding on both sides.

1.4 Medical physics in radiation protection

The present report excludes any consideration of the broader aspects of radiation protection outside medical establishments, as carried out by health physicists.¹ Nevertheless, the close relationship between the medical

¹ International Atomic Energy Agency (1965) *The provision of radiological protection services*, Vienna (IAEA Safety Series No. 13); WHO Expert Committee on Radiation (1963) *Public health responsibilities in radiation protection*, Geneva (*Wld Hlth Org. techn. Rep. Ser.*, 254).

physicist and the health physicist should be acknowledged. Firstly, their training requirements have much in common. Secondly, many important aspects of radiation protection relate to medical uses of ionizing radiation or radioactive materials.¹ The medical physicist has a significant part to play in the study of various environmental and epidemiological problems in world health care.²

2. WIDER APPLICATIONS OF PHYSICS TO MEDICINE

Physics applied to medicine has been largely concerned for some decades with matters relating to ionizing radiation as described in sections 1.1 to 1.4. The Committee recognizes that there has long been scope for a much wider application of physics and of other branches of science and technology to medicine.

Moreover, the Committee believes that scientific and technological contributions to medicine are in a rapidly expanding phase, for two reasons :

1. The demonstrated success of physics in branches of medicine such as cardiology, neurology and psychiatry, ophthalmology, otology, and surgery is currently generating interest in the interplay of physics and medicine.³

2. The diversity of the applications of physics to medicine is rapidly increasing, through advances in electronics, ultrasonics, laser techniques and so on.

It is believed that such applications of science and technology to medicine will grow in importance relative to the applications at present identified as medical radiation physics.

3. MEDICAL PHYSICS TEACHING AND RESEARCH

Medical physics may be thought of as a bridge between medicine and the physical sciences, and therefore the medical physicist has unusual teaching responsibilities. He is involved in the teaching of three different groups :

¹ Great Britain, Committee on Radiological Hazards to Patients (1960) *Second report*, London, H. M. Stationery Office.

² United Nations, Scientific Committee on the Effects of Atomic Radiation (1966) *Report. General Assembly, Official Records : Twenty-First Session, Supplement No. 14*, New York.

³ Fowler, J. F., ed. (1962) *The scope of physics applied to medicine*, London, The Hospital Physicists' Association.

- (a) Less experienced medical physicists in large medical institutions ;
- (b) Physicians, particularly radiologists and other specialists with higher education ;
- (c) Nurses and operational personnel, such as radiographers, radio-isotope technicians, and laboratory assistants.

Because medicine is becoming increasingly scientific and complex, the Committee considers that the principles of physics must become more widely understood throughout the whole of medicine and that, in addition to the teaching activities listed above, the further teaching of physics as applied to medicine needs to be incorporated in the medical school curriculum.

The history of the development of scientific medicine has shown the important part played by research in physics and in technology. The need for research is very likely to increase. The physicist brings to medical problems an analytical, quantitative approach that can be of great service to research. His contributions may be at the fundamental level—for example, in the study of the behaviour and limitations of information transfer systems or the physical factors affecting radiosensitivity of cell populations. In addition, physicists contribute at the applied level, in the introduction and development of useful techniques, particularly in the instrumental field, for example in connexion with monitoring of patients. Much of this type of research calls for very close collaboration between medical and non-medical workers.

The teaching and research responsibilities outlined above emphasize the professional nature of the work of the physicist in medicine. The Committee recommends that, in order to meet these responsibilities effectively, medical physicists should be appointed to medical school faculties and to professional posts in hospitals.

4. PRESENT AND FUTURE NEEDS IN MEDICAL PHYSICS

Sections 1-3 indicate the importance of medical physics throughout the medical field, not only in the context of service to medical specialties, including radiotherapy, nuclear medicine and diagnostic radiology, but also in the teaching of medical and paramedical personnel, in basic research, and in technological development. Planning medical physics services requires estimates of the present needs, of the quantity and calibre of the persons available for training, and of the growth potential in this specialty.

4.1 Survey of present situation

The number of practising medical physicists in different countries varies widely, depending not only on the development of medical services

in those countries, which is obviously related to their wealth and general educational standards, but also to some extent on national attitudes to the relationship between non-medical professional personnel and physicians.¹ The technically more advanced countries possess a work-force of medical physicists of the order of 2 to 5 per million inhabitants, whereas in less developed countries there may be none in the entire country. The number is not always related to the level of technology, for in a number of countries with few medical physicists there is a thriving atomic energy programme which employs personnel of somewhat similar scientific background. Even in the more advanced countries, there is an urgent demand for more medical physicists, due not only to the increasing importance of diagnostic radiology, radiotherapy and nuclear medicine, but also to the advent of new techniques, such as those mentioned in section 2. It has also become evident that the participation of physicists in the work of medical institutions has intensified the demand for them by its own success.

In many parts of the world, particularly in developing countries, cancer control and treatment programmes have had relatively low priority in the past because of the pressure of other public health problems, such as communicable diseases. However, these diseases are being brought rapidly under control, with the result that more of the population are reaching the age at which the incidence of malignancy is high. It may therefore be expected that cancer will become a larger problem and will demand a higher priority in public health planning, particularly with respect to the provision of radiotherapy facilities. The value of nuclear medicine is also being demonstrated, for example, in the study of thyroid disorders and in the application of scanning techniques. The initiation and development of such medical programmes are largely dependent upon the availability of medical physics services.

4.2 The establishment of medical physics as a specialty

In many countries, the supply of scientific and technical personnel is insufficient to meet all needs. Although it is realised that the establishment of medical physics services may divert scientific personnel away from industry and away from teaching and research in other fields, if improvement in medical services is a national goal, it is essential that the development of medical physics as a specialty be encouraged through government action.

The Committee therefore recommends that, in every country, the ministry of health or other government authority responsible for health

¹ A recent IAEA survey gives information on the numbers of medical physicists employed in radiotherapy centres throughout the world: *International Directory of High-Energy Radiotherapy Centres*, IAEA, Vienna, 1968.

should take the steps needed to develop medical physics services. The responsible authorities should maintain close liaison with the atomic energy authorities in the country, particularly with respect to radiation protection.

4.3 The initiation of programmes in medical physics

The establishment of medical physics programmes in countries where medical physicists are urgently needed should proceed in several stages :

Initially, established programmes in other countries may be utilized for training a small cadre of medical physicists. This should be a continuing policy, preferably through the award of fellowships on conditions that strongly encourage or virtually require the return of the fellow to his home country and to an established position. Advice on the selection of fellows and of training programmes is available through IAEA and WHO.

It is desirable that any country with the means to establish its own training centre should do so as soon as possible. This avoids the problem that often arises when people are sent for training to other countries where the services may be much more advanced and the equipment available more sophisticated than in their own country.

It is probably best in the earliest stages to provide training at a single centre to which students from other regions of the country may come, rather than to provide small decentralized teaching activities. Financial assistance to students attending such a centre should be provided in the form of fellowships. Later, one or more regional centres may also be established.

A national or regional training centre should be associated with a university, preferably one with a medical school. The centre may serve several neighbouring countries. It may be staffed by returning fellows. In the formative stages, visiting teachers should be engaged for long periods (such as one semester) to assist in the teaching programme. The centre should have sufficient physical facilities and personnel to allow the physicist who has completed his training to refer problems to it and to receive assistance from it.

Support for such programmes may be obtained through international agencies, bilateral aid programmes, and private philanthropic organizations. Both IAEA and WHO have already given vigorous support to a variety of medical physics activities. Assistance may be provided in the form of fellowships, training courses, advisory services, and research contracts, and both organizations have information and data services.

The government authorities responsible for the medical physics programme should periodically evaluate its effectiveness in meeting the need for medical physics services.

4.4 Ways of reducing needs in medical physics

There are several methods, both organizational and technical, of reducing the needs for manpower and equipment and permitting training programmes to be introduced more gradually and with a smaller investment, particularly in the early stages of development.

A medical physics programme should be initiated at a single, large medical centre, preferably one in the largest population group of the country and associated with a university. Medical physicists working at this centre should have service responsibilities for medical physics work in medical institutions in the surrounding region and should pay regular visits to these institutions to perform basic services, such as radiation source calibration, radiation safety surveys, and consultation with the medical staff on technical problems. Co-operation with the physician in certain activities, such as treatment planning and supervision of a nuclear medicine laboratory, is best undertaken by medical physicists employed full-time at the institution concerned. In the early stages of development of the medical physics service, when such personnel may not be available, these responsibilities may be undertaken to a limited extent by the medical staff, providing they have received appropriate training.

Considerable help in radiotherapy treatment planning can be obtained from published data, particularly depth dose tables, isodose charts,¹ and atlases of radiation dose distribution.² The use of such atlases should, however, be supplemented by individual treatment planning.

The use of digital computers for treatment planning in radiotherapy is growing rapidly and will eventually be helpful in reducing manpower needs.³ However, the technological facilities must first be developed and the special personnel required for maintenance and programming of computers must be trained. It is likely that simple analogue devices will be more helpful in the short term.

There is a strong case for the provision within the medical physics service of a mechanical workshop where small repairs or adjustments can be made and simple ancillary equipment constructed. This is of particular significance when satisfactory maintenance services are not available outside the institution.

¹ IAEA (1964) *Radiation data for medical use, Catalogue No 1*, Vienna; Tsien, K. C. & Cohen, M. (1962) *Isodose charts and depth dose tables for medium energy X-rays*, London, Butterworths; *Depth Dose Tables for Use in Radiotherapy: Brit. J. Rad.*, 1961, Supplement No. 10.

² IAEA, *Atlas of radiation dose distributions*, 3 vol., Vienna: vol. 1, *Single-field isodose charts*, 1965; vol. 2, *Multiple-field isodose charts*, 1966; vol. 3, *Moving-field isodose charts*, 1967.

³ IAEA (1966) *Computer calculations of dose distributions in radiotherapy*, Vienna (*Techn. Rep. Ser.*, No. 57).

The need for special training and the manpower requirements for maintenance activities can be reduced by standardizing the types of equipment in use. This should also help to shorten the time required for repairs and maintenance and reduce the number of spare parts that need to be carried. Such a policy is particularly important in the choice of major items of equipment for use in countries remote from the place of manufacture.

An important additional consideration in choosing equipment is its relative simplicity and reliability. Thus, a cobalt-60 teletherapy unit might be preferred to a linear accelerator in the early stages of a radiotherapy programme.¹

To make the best use of the special skills of the medical physicist he should have the help of adequately trained technicians. The training of such technicians is discussed in section 5.2.

The manpower needs for teaching can be reduced and the efficiency of teaching increased by employing electromechanical teaching aids. Programmes for use in teaching radiological physics and other subjects are being developed.²

5. TRAINING AND PLACEMENT OF MEDICAL PHYSICISTS

The training and subsequent placement of medical physicists will clearly be determined by the functions they are required to fulfil, which are reviewed in detail in sections 1-3. There will, however, be an emphasis on different functions in different medical environments. For example, a small hospital without teaching responsibilities and with limited resources as regards personnel and equipment will probably employ a single medical physicist whose principal function will be routine service. At the other extreme, a large teaching hospital may employ a group of physicists rendering services to several departments, teaching a variety of medical and paramedical groups, and probably carrying on research. Some of these will be junior physicists whose main duties are providing services and undertaking elementary teaching, while the others will be senior physicists

¹ Joint IAEA/WHO Meeting (1966) *Planning of radiotherapy facilities*, Geneva (*Wld Hlth Org. techn. Rep. Ser.*, 328).

² See Chervis, D. N. & Chervis, B. H. (1964) *Physics and principles of diagnostic radiology*, Chicago, Year Book Medical Publishers; and Meckstroth, G. R. et al. (1964) *A programmed introduction to radiation protection*, New Orleans, Tulane University School of Medicine. *A guide to programmed instruction materials*, compiled by The Center for Programmed Instruction, Inc., is available from the Superintendent of Documents, US Government Printing Office, Washington, D.C., USA; and *Programmes in the health sciences, a bibliography of published self-instructional material* from the National Centre for Programmed Learning, School of Education, University of Birmingham, Birmingham 15, England.

with supervisory functions and responsibility for more advanced teaching and research. These differences in responsibility and function necessarily affect the types of personnel recruited and the design of training programmes.

5.1 Recruitment

The conditions of employment of persons providing these medical physics services will vary from country to country according to the administrative arrangements in force. In some instances, such services will be provided by medically trained personnel who have also received appropriate training in medical physics. In other countries, however, these services will be provided by personnel with a basic training in physics and special training in the problems of physics applied to medicine. Clearly, training programmes must be tailored to the previous educational background of the trainee. The Committee considers that these programmes should be sufficiently flexible to enable both types of recruit to be trained.

Where the principal aim is to recruit persons with a basic science education, the desirable prerequisite is a degree in physics. However, persons with qualifications in applied mathematics or some branches of engineering may be equally suitable, and those with degrees in chemistry, biology or in the medical sciences should also be considered. For physicians, specialist training in radiology is desirable. Candidates for more advanced training will usually be selected from students who demonstrate superior ability in the training programme and from junior medical physicists with some experience. In the recruitment of persons who will largely be concerned with research, intelligence and reliability are probably more important than the specific nature of the initial training.

It is realised that at present and for some years to come some countries will not have sufficient candidates with even the minimum standards suggested, so that it will be necessary to accept some persons with only secondary school education for training in many of the routine duties set out in section 1. The Committee does not feel that this is a policy that should be encouraged, but recognizes that it is necessary to provide physics services and that this may be the only way in which they can be staffed at the present time. Furthermore, some recruits with only a limited academic background react so favourably to the opportunity of service in hospitals that they eventually attain a high degree of competence

5.2 Training programmes

Ideally, training in medical physics combines formal educational training with in-service training in an established department of a medical institution. Opportunities for training vary considerably from country to country, however, and where formal training courses are lacking, in-service training alone

may have to suffice. In all cases, a period of in-service training is essential and no person should be considered fully trained unless he has spent an appropriate period working under guidance in an established department.

The specialized training of medical physicists is best undertaken at the postgraduate level. Graduates in science, engineering or medicine destined for routine work in medical physics require a formal training course lasting at least one year full-time or two years part-time, with a period of in-service training extending over at least two years.

The syllabus of the formal training course will depend very much on the original specialization of the trainee and on the branch of medical physics he intends to enter. For a physics or engineering graduate who is training for work in medical radiation physics, the first half of the formal training course may be mainly devoted to simple instruction in the basic medical sciences of biology, anatomy, physiology and biochemistry. During the second half of the course, specialized instruction may be given in radiation and radioactivity physics, electronics, statistics, physical aspects of radiology and nuclear medicine, radiation biology, and radiation protection. For graduates in medicine who are training for similar work, the first half of the course may be mainly devoted to basic instruction in mathematics and physics. Instruction during the second half can then be very similar to that for science graduates. Such courses should lead to a diploma, master's degree, or similar qualification in medical physics.

Trainees destined to occupy leading posts in medical physics—for example, as heads of departments in medical institutions or teachers in university departments—may undertake more extensive formal training programmes leading to doctorates in medical physics or similar qualifications. Such programmes may extend over three or four years, commencing with a course similar to that described above, but with the addition of some more advanced topics, proceeding to a period of research on a chosen subject and culminating in the preparation of a thesis. Advanced courses in the basic medical sciences, such as physiology may be included, since research in medical physics is often closely associated with medical practice. In addition, advanced technical studies concerned with new physical instrumentation may be appropriate.

The Committee considers that theoretical training alone is quite inadequate and that the foremost requirement is practical training, preferably of an in-service nature. This applies especially to regional training programmes in developing countries. Physicists providing services to medicine must have adequate training in the clinical applications of their work by physicians and others.

Whatever their training, medical physicists will be used inefficiently unless a sufficient number of appropriately trained technicians are also available to assist them in their duties. Technicians are needed for routine work in laboratories and clinics, for routine inspection work in connexion

with radiation protection, and also for the maintenance, testing and repair of instruments.

Technicians recruited for these duties should normally have a background ranging from secondary school to technical college education. They should undergo a period of formal training in the special field in which they are to be engaged and a period of in-service training.

Medical physicists must themselves participate in the training of technicians, during both formal and in-service training.

5.3 The profession of medical physics

The maintenance and growth of medical physics in a country will depend on its relative attractiveness as a profession. Working conditions and remuneration comparable to those enjoyed by scientific and technological staff in other professional fields must be provided. It is important that adequate space, equipment and supporting facilities be made available and that research endeavour be encouraged. In addition, a system of promotion within institutions is necessary, so that good career prospects can be offered to those intending to enter this profession.

The ultimate strength of the profession will depend upon the establishment of independent departments of medical physics with well-trained and creative leadership. This is the best way to ensure that able and energetic persons are attracted into this field.

The Committee emphasized that in those countries where provision is made for medical physics training there should also be adequate employment opportunities. There is evidence that, in the past, persons specially trained to meet a country's needs in medical physics have been unable to obtain employment in this specialty and have eventually accepted employment in competitive scientific fields. Not only must positions be available, but they must be adequate in status and conform to the conditions set out above.

The favourable influence on the profession of medical physics that can be exerted by the creation of professional societies has been recognized in various surveys.¹ In the related fields of radiation research, radiology, and health physics, professional societies have contributed greatly to the advancement of these specialties. The Committee urges all national or regional groups of medical physicists to consider the importance of establishing a professional society; the relatively young International Organization for Medical Physics (IOMP) is expected to become a strong positive influence for maintaining scientific and professional standards and encouraging the development of this specialty.

¹ Parker, H. M. (1965) *Research report on the training of radiological physicists*, US Public Health Service; Mayneord, W. V. (1966) *Medical physics*. In: Rotblat, J., ed., *Aspects of medical physics*, London, Taylor and Francis, pp. 1-12.

6. SUMMARY AND RECOMMENDATIONS

The Committee believes that the physical sciences are destined to play an increasing role in the practice of medicine and that medical physics should be recognized as a profession within the health services. At present, the applications of modern medical physics are seriously limited by lack of facilities and of personnel with appropriate levels of training; also, specific government support for medical physics is inadequate, with detriment to the advance of medicine.

The Committee made the following recommendations:

1. Medical physics should be recognized in all countries as a scientific discipline with full professional status in universities, medical schools, hospitals and allied institutions.

2. Medical schools should appoint teachers in medical physics to their faculties and incorporate in their curricula instruction in the physical sciences as applied to medicine.

3. In all countries, and especially in those with few or no medical physicists, the government authorities responsible for the health services and for education should initiate or expand medical physics activities by:

(a) the establishment, support, or expansion of training programmes for both medical physicists and technicians; and

(b) the establishment of an appropriate number of posts for physicists in medical institutions, with opportunities for promotion and remuneration comparable to those of other physicists in the country.

4. In countries that at present have few or no medical physicists the training programmes to be established should aim initially at developing a cadre of medical physicists who will be responsible for teaching within those countries.

5. Hospitals requiring medical physics services should be provided with adequate space, equipment and supporting facilities, including workshops and qualified technicians for such work.

6. IAEA, WHO and other interested international organizations should continue and intensify their support of training programmes in medical physics.

7. IAEA and WHO should provide support for international and regional seminars and other technical meetings on medical physics and its various aspects.

8. IAEA and WHO should continue to jointly review the broad applications of the physical sciences and engineering to medical practice and research.

Annex

LIST OF UNPUBLISHED WORKING PAPERS

- Radiation physics in a hospital service*, by R. D. Ayyar (RHL/WP/67.4)
- Present situation in medical radiation physics in Thailand*, by Tawan S. Bunnag (RHL/WP/67.5)
- A radiation physicist in nuclear medicine in Poland*, by O.A. Chomicki
- Comments on criteria for competence and training of medical physicists*, by J. H. Lawrence and H. W. Parker (RHL/WP/67.6)
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