The European Federation of Organisations for Medical Physics
Policy Statement Nr. 1

Medical Physics Education and Training: The present European Level and Recommendations for its Future Development

Introduction

The European Federation of Organisations for Medical Physics (EFOMP) was founded during the second conference of representatives from European organisations for Medical Physics, in London in May 1980. The current membership includes eighteen national organisations which together represent about 2500 physicists and engineers in the field of Medical Physics.

It is one of the objectives of the Federation to formulate recommendations for education and training in Medical Physics that might be suitable for the establishment of comparable European qualifications. This task was assigned by the Council of the Federation to the Committee for Education and Training consisting of the following members: Professor A. Kaul, F.R.G. (Chairman), Dr. A. Benini, Italy, Dr. D. H. Bekkering, Netherlands, Dr. J. Chavaudra, France and the late Professor R. Ellis, United Kingdom. For the preparation of such recommendations it was necessary to be informed about the current state of development of education and training in Medical Physics in the individual European countries. For this purpose, two fact-finding inquiries were conducted, as a result of which 19 national organisations for Medical Physics and/or respective sections of other scientific organisations, described the current level of education and training in the individual countries. The essential questions contained in the inquiry and the results as well as the future work of the European Federation in education and training are summarised in the present study,

The report of the Committee was discussed at the EFOMP Symposium in Hamburg in 1982, held in conjunction with the 6th International Congress of Medical Physics. Comments from national organisations, members of EFOMP, were brought to the EFOMP Council Meeting in Bordeaux in September, 1983, where this policy statement was given formal approval.

1. Inquiry

Ten questions were asked on the following subjects, if applicable:

1. The type of additional education and training (postgraduate courses and/or on-the-job training) and the entry qualification;
2. The length of the additional education and training and the nature of the final examination, accreditation and official recognition;
3. Collaboration with other bio-science sections, in particular with biomedical technicians and engineers.

In addition available course prospectuses were requested.

2. Results

Organisations for Medical Physics of the following countries participated in the inquiry: Belgium, Federal Republic of Germany, Denmark, German Democratic Republic, United Kingdom, Finland, France, Greece, Netherlands, Ireland (Republic), Italy, Yugoslavia, Norway, Austria, Poland, Sweden, Switzerland, Spain, Turkey. The results of the inquiry may be summarised as follows (see table 1)

Table 1. Postgraduate education and training (on-the-job and courses) in Medical Physics

				Duration			Certification	
	Country	Formally regulated	Individually regulated	on-the-job (in years)	courses (in hours)	Exami-nation	State	Private[4]

1	Austria	-	+	-	-	-	-	-
2	Belgium	-	+	1	465	+	-	+
3	Denmark	-	+	-	-	-	-	+
4	England (UK)	+	+	<= 4[2]		+	(+)	+
5	Federal Republic of Germany	+	+	3	360	(+)	(+)	+
6	Finland	+	-	1+4		+	+	-
7	France	+	-	3		+	+	-
8	German Democratic Republic	+	+	2	180[6]+320[5]	+	+	-
9	Greece	+	-	600 (hours)	463	+	+	-
10	Ireland (Republic)	-	+	-	-	-	-	-
11	Italy	+	+	2	500	+	+ (?)	+
12	Jugoslavia	-	+	3-4		+	-	+
13	Netherlands	+	-	2		-	-	+
14	Norway	-	+	-	-	-	-	-
15	Poland	-	+	3	-	+	+ (?)	- (?)
16	Spain	-	+	-	-	-	-	-
17	Sweden	+	-	3+4[3]		+	+	-
18	Switzerland	-	+	-	-	-	-	-
19	Turkey	-	+	>= 1	120	+ (?)	-	+

(+) approved but not as yet implemented
[1] as temporary rule Simultaneously possible
[2] depending on initial qualification (B.Sc., M.Sc., Ph.D.)
[3] if a higher qualification is the objective, e.g.- Ph.D. or "Senior Medical Physicist"
[4] affiliation, scientific association, University
[5] scheduled lectures
[6] sit-in lectures
? data incomplete

2.1 Type of additional education and training and basic qualification

In 10 countries, i.e. nearly half of those participating in the inquiry, additional education and training in the field of Medical Physics is provided solely within the framework of professional practice and, in some cases, is supplemented by a period of introduction - given by an experienced colleague - to the tasks assigned to a hospital physicist. However, this does not preclude the fact that in some countries, e.g. Belgium and Austria, structured courses in Medical Physics are additionally offered. In the remaining countries, additional education and training programmes have been established but can only be put into effect gradually.

Such countries as Finland, France, Greece and Sweden have had several years of experience with regular education and training programmes, while experience in the United Kingdom, the German Democratic Republic, the Netherlands and the Federal Republic of Germany is more recent.

The Hospital Physicists' Association in the **United Kingdom**, the largest national association in Europe, requires professional work at a hospital with simultaneous participation in additional education and training courses and practical

work performed under the supervision of an experienced medical physicist as an 'assessor', Obligatory topics for additional education and training are Anatomy and Physiology. Safety in the field of ionizing and non-ionizing radiation, including the handling of electrical facilities, as well as an individual selection of areas of endeavour, such as Diagnostic Radiology, Radiation Therapy, Nuclear Medicine, Physiological Measurement and Computer Science. The basic qualification is a Bachelor of Science degree (B.Sc.). The academic degree of M.Sc. or Ph.D., respectively, may be attained during the process of additional education and training.

The system of additional training in **Finland** is limited to Medical Radiophysics and characterised by postgraduate on the-job training. A formal study of Physics or Electro-Technology is required, concluded by the academic degree of M.Sc. as well as several years of basic instruction in Physiology, Anatomy, Biophysics, Radiobiology and Clinical Radiobiology, Radiation Protection and Radiation Hygiene, at a university or other research institution.

In **France**, Medical Physics is practised by various specialists who have been educated as engineers, physicists, medical doctors or in other disciplines. Almost no formal education or qualifications are defined, except for the field of Radiology. In this case, hospital physicists' qualifications and an agreement procedure have been regulated by law since 1977. Hospital physicists following this scheme must have a university degree in Physics, Informatics or Techniques as a basis for a specific postgraduate training, both theoretical and practical. This training, dealing with Physics, Radiobiology, Computer Techniques and the medical applications of Physics, includes nine months in the University Paul Sabatier, Toulouse, and eight weeks in the University of Paris-Sud and in the institut Gustave Roussy (about 350 hours). It leads to an M.Sc. in Medical (Radiological) Physics. Students must present a report on clinical research in one of the radiological subspecialties of Medical Physics or Radiobiology. A written, oral and practical examination is given by a mixed commission of physicists and physicians, leading to an accredited Diploma in Radiological Physics. After this about 90% of the selected students prepare a Ph.D. in Medical Physics before entering the profession. In-service training, the length of which is not specified, follows.

Due to legal requirements in the **Federal Republic of Germany** for specially educated physicists in Radiotherapy, radiopharmaceutical applications and Radiation Protection, the German Association for Medical Physics has ratified (March, 1980) regulations for postgraduate education and in-service training in Medical Physics. The training takes at least 3 years. As a requirement for professional employment in a specialty of Medical Physics such as Nuclear Medicine, the physicist in the training programme will be given additional knowledge in both his specialty and the general field of Medical Physics by lectures, seminars and practicals of at least 360 hours total duration. Accreditation will be granted by an official commission which will check all professional and educational prerequisites. A first university postgraduate course, for a period of 3 years, consisting of 5 hours education per week during the term has been started at the Free University of Berlin (West).

The **German Democratic Republic** usually requires postgraduate on-the-job training by so-called "Natural Science and Technology Cadres" for certified psychologists and sociologists of the Public Health Service as well as physicists. For physicists in the medical field courses are organised by the Section for Clinical Radiation Physics of the Association for Medical Radiology. The study programme includes practical professional experience, autonomous study, lectures and courses with emphasis not only on the fundamental physics of ionizing radiation but also on Dosimetry, Radiobiology and Radiation Protection, Health Politics, Health Service and its organisation. The basic qualification for entering a postgraduate on-the-job training programme is a completed university study as a certified physicist or engineer and additional-work for a minimum of 1 year in the Public Health Service.

The current system of additional training in **Greece** is also characterised by a combination of courses emphasising Physiology, Anatomy, Radiobiology, Clinical Radiophysics and Physics of non-ionizing radiation and Electronics as well as by additional practical on-the-job training. Participation in the additional training programme requires a completed university training in Physics (M.Sc. or equivalent academic degree).

In the **Netherlands**, education and training of clinical physicists follow a postgraduate on-the-job programme, as established by the Dutch Society of Clinical Physics, at a hospital under the supervision of a 'mentor' with simultaneous course participation. Basic qualification is an academic degree of M.Sc. The courses are set up in blocks and their subjects correspond with the respective field of Clinical Physics, e.g. Physics in Radiation Therapy, Nuclear Medicine, Physiological Measurement and Technology.

In **Sweden** the formal competence rules for Swedish hospital physicists prescribe the levels of education and training required for two different grades, (1) An appointment as an assistant hospital physicist requires a "fil.kand." (B.Sc.)

degree from a university or an M.Sc. degree from a technical university where radiation physics has been studied. The theoretical education takes at least 4 years, 3 years in-service training is also required of which at least 1.5 years must have been spent in a hospital physics department. (2) An appointment as a hospital physicist requires a Ph.D. in radiation physics or the equivalent which takes an additional 4 years. This degree includes 1 year of courses and 3 years of scientific work far a doctoral thesis.

2.2 Length of additional education and training, final examination, accreditation and official recognition

The length of postgraduate on-the-job training extends from a minimum of 1 year to a maximum of 4 years but may require 7 years if an advanced qualification in Medical Physics is desired, e.g. 'Qualified Hospital Physicist' in Sweden, and if combined with an academically advanced study awarding a doctorate. An average of 3 years of postgraduate on-the-job training is generally required. The course hours, in as far as they are not specified and are scheduled during the postgraduate on-the-job training period, amount from 120 to 500 hours, with a mean of 400 hours.

In nearly two-thirds of the 19 countries participating in the fact-finding inquiry, a final examination after completion of the education and training programme is required or will be in future. Examinations are given in written and/or oral form and, in some cases, are connected with the award of a special title, e.g. 'Fachanerkennung für Med. Physik' (Federal Republic of Germany), 'Fachphysiker - Ingenieur für Strahlenphvsik' (GDP), 'Senior Hospital Physicist' (Finland, Turkey) or 'Diplome Etudes Approfondies Specialité Physique Radiologique (France).

An official recognition of this qualification over and above the regular study of Physics or Engineering Sciences is presently awarded in only 4 countries. The same seems to apply to two more countries (information incomplete, and in an additional two countries (United Kingdom and Federal Republic of Germany) it is deemed as desirable.

2.3 Collaboration with other biomedical sections

The results of the fact-finding inquiry clearly demonstrate that with the exception of the G.D.R, there is a lack of collaboration with other scientific biomedical associations in the area of additional education and training for medical physicists, apart from the fact that in 5 countries postgraduate training in Biomedical Technology is available, as comparable to Medical Physics. However, even in these instances, the mailing address of the national organisation responsible was not known, indicating the absence of an exchange of information.

3. Summary of Results of the Inquiry

According to the results of the fact-finding inquiry, a formally regulated additional education and training programme for physicists and university graduates in the engineering sciences with emphasis on Technological Physics exists in nearly half of all the European countries (9 from 19) that participated in the general inquiry. In the remaining countries, the postgraduate on-the-job training in hospitals or Nuclear Physics sections is managed on an individual basis, i.e. not following a generally recognised nationwide concept. This approximately applies also to final examinations, whereby such examinations may actually be given, even though a nationwide formally regulated additional training programme does not exist in the respective country. To qualify for postgraduate training usually calls for a completed university study in Physics or the engineering sciences with a certification comparable to a diploma. The length of postgraduate on-the-job training amounts from a minimum of 1 to a maximum of 4 years. However, in cases where a higher qualification in Medical Physics is desired (e.g. 'Qualified Hospital Physicist) combined with the achievement of a doctorate (Ph.D.), this period may be extended to 7 years. On the average, 3 years are usually required for postgraduate on- the-job training, mostly with an average of 400 course hours. Only in 4, or perhaps 6 of 9 countries with formal postgraduate training programmes, an official recognition of the added qualification is awarded as comparable to that of a medical specialist. Two additional countries are planning the same recognition.

The individually responsible work of a physicist in the therapeutic application of ionizing radiation to man is legally required in 4 countries (Federal Republic of Germany, German Democratic Republic, France and Greece).

4. Objectives of the European Federation.

Based on the results of the fact-finding inquiries, the objectives of EFOMP considering postgraduate education and training may be summarised as follows:

- Development of a scheme for postgraduate education and training and recommendation of a time period required

for a postgraduate education and training programme;
- Support of an exchange of physicists between countries where a regular postgraduate training programme is already in effect.

4.1 Scheme for Postgraduate Education and Training

4.1.1 The entry requirements for the training scheme

A primary need in planning a basic training scheme for, medical physicists is to agree upon for whom the scheme should be designed. Medical Physics has evolved in different ways in different countries and, in the past significant contributions to this field of work have come from individuals whose first degree was **not** in Physics. Thus graduates in Mathematics, Engineering, Chemistry, Medicine and other disciplines have entered the field and become accepted as members of the profession of Medical Physics.

The application of Physics to Medicine requires first foremost a high Standard of education and training in the ideas, principles and techniques of Physics. Thus today, it is now almost universally recognised that an entrant to Medical Physics training should hold a first degree with Physics as major subject. The Council believes that entrants to Medical Physics training should have, as a minimum requirement, the Bachelor's degree (B.Sc.) or its equivalent, in Physics. Individuals with degrees in Mathematics, Engineering, Chemistry, Biology or medical sciences could also be considered but would need preparatory training to ensure that their knowledge of Mathematics and Physics is up to the required standard (fig. 1). Such preparatory additional training courses in Physics are regarded as outside the provisions of the Medical Physics training scheme.

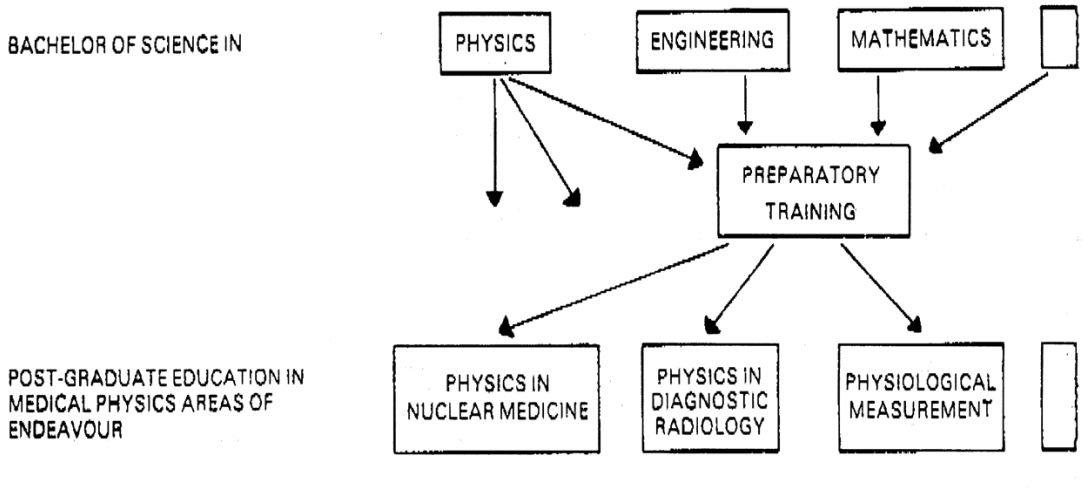

Fig. 1. Entry requirements for the training scheme of postgraduate education

4.1.2 The length of the education and training period and its subjects

The education of medical physicists can be divided into three stages. After a first step of bringing the physicist up to a basic standard (B.Sc.) in Physics, Mathematics and other relevant topics in Natural Sciences, the second step is to introduce Medical Physics in postgraduate education. The third step is in-service training in hospitals. After finishing this the physicist can be recognised as a medical physicist at an appropriate level. It should also be possible to reach a senior level by further education and training, and to get a higher academic degree, i.e. M.Sc., Ph.D. or equivalent in Medical Physics,

Postgraduate education in Medical Physics should follow as a formal course of lectures, seminars, practicals, tutorial work by means of on-the-job training and professional work (see fig. 2). A minimum of two years for professional work including on-the-job training is required. It should be possible from the beginning at this stage to concentrate on a Medical Physics speciality as an area of endeavour but the courses should also include other aspects of Physics applied to Medicine (see table 2) and mandatory subjects irrespective of the individual area of endeavour (see table 3). On-the-job training should be done under the supervision of a medical physicist at senior level. It is an advantage if during on-the-job training the physicist gets opportunities to do individual work on projects. The on-the-job training period can be included in the second stage of postgraduate education by formal courses if this is more practical, The total length of the postgraduate education and training period by lectures, seminars or practicals included in professional

work, or in addition to, shall be not less than 300 to 400 hours and will comprise mandatory subjects, subjects of the individual area of endeavour (Medical Physics speciality or sub-speciality) and optional subjects of Medical Physics (see fig. 3).

Table 2: Medical Physics specialities and subspecialties

MEDICAL PHYSICS SPECIALITIES	
RADIOLOGICAL PHYSICS IN:	
	DIAGNOSTIC RADIOLOGY
	NUCLEAR MEDICINE
	RADIATION THERAPY
PHYSIOLOGICAL MEASUREMENT IN:	
	CARDIOLOGY
	OPTHALMOLOGY
	AUDIOLOGY
	NEUROLOGY
	.....
EACH OF THESE SUBSPECIALITIES CONTAIN	
	APPLIED ELECTRONICS
	INSTRUMENTATION
	DATA PROCESSING

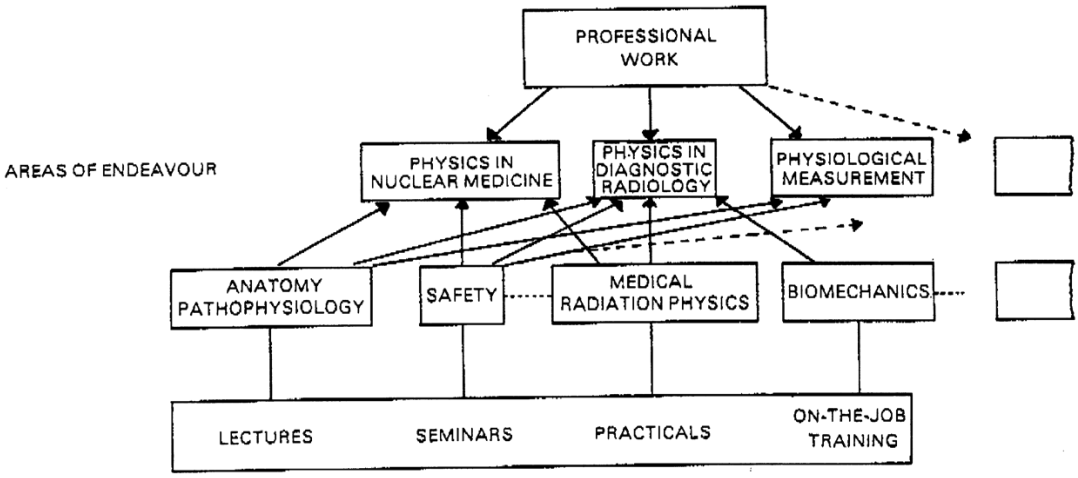

Fig. 2. Training scheme for postgraduate education

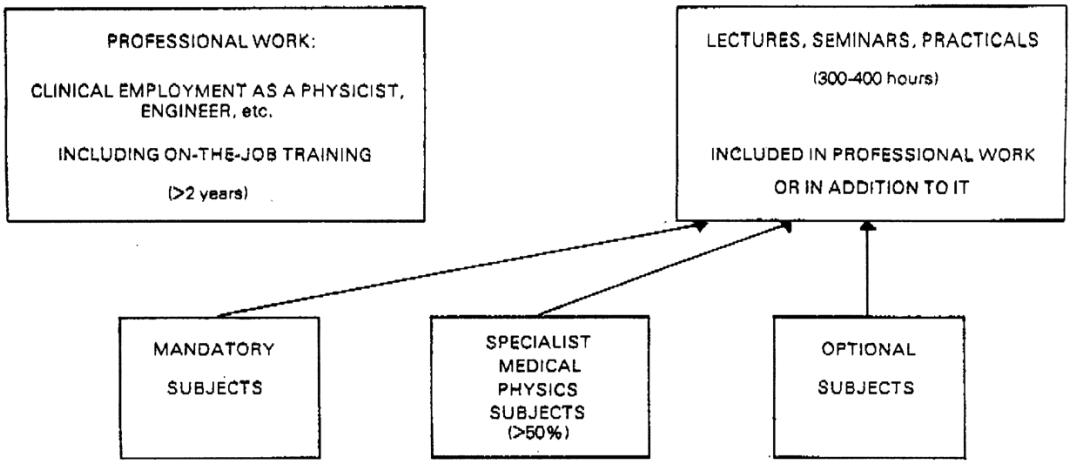

Fig. 3. Total length and subjects of the postgraduate education and training period

The wording of the recommendations of the 1972 Kiel WHO Seminar on these matters was: The minimum period of training should normally correspond to two years of full-time work, including a formal course and an introduction to in-service training whether as a paid hospital employee or not. The in-service training should not begin before the start of the formal course and both should preferably be taken in the same institution. Where this desirable situation cannot be met and the formal course is given by an educational establishment separated from a hospital, the in-service training should either be closely supervised by this educational establishment or be in an established Medical Physics department headed by a senior medical physicist.

Table 3: Mandatory subjects

MANDATORY SUBJECTS	
ANATOMY/PATHOPHYSIOLOGY	
SAFETY	
	IONISING RADIATION
	ULTRASOUND
	ELECTRICAL
	LASER
	MICROWAVE
	ULTRAVIOLET
	CHEMICAL
	BIOLOGICAL
	MECHANICAL WORKSHOP
GENERAL HEALTH CARE AND HOSPITAL MANAGEMENT	
MEDICAL STATISTICS	
INFORMATICS	
PRINCIPLE OF QUALITY CONTROL AND ASSURANCE	

4.1.3. Examination and certification

Examination systems vary from one country to another and a universal, detailed system cannot be prescribed. Assessment of the training can be done on an individual basis by written examination, report and oral examination of the candidate or by checking all relevant submitted documents indicating whether or not the candidate fulfils the presupposition to be given certification (see fig. 4). If both the corresponding national training scheme and the level of

postgraduate education by lectures, seminars, practicals and on-the-job training are recognised by EFOMP to be in accordance to its recommendations the accreditation can be extended by means of a European certificate.

4.2 National Training Centres, Exchange of Medical Physicists and Support from international Organisations

EFOMP will as a further step to fostering education and training on a European level, encourage the establishment of national training centers providing both formal courses and in- service training for their own medical physicists but also for physicists from other European countries. Other international bodies may contribute to this aim in various ways. The Council of the Federation will seek to collaborate with such other international bodies in organising: fellowships for training students on an individual or group basis; national, regional or international training projects; provision of lecturers and other experts, equipment and supplies; promotion of the publication of manuals and other teaching aids.
