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# Role of National Society for Biomedical Engineering and Medical Physics in education on medical physics in Yugoslavia

## ABSTRACT

*Yugoslav Society for Biomedical Engineering and Medical Physics (YUBEMP) is the only national society that coordinates education with professional activities and public promotion of medical physics (MP) in Yugoslavia. YUBEMP's program, created in collaboration with other professional societies, institutions and universities, is directed to synchronize actions in the field of MP. The current state in Yugoslavia is evaluated according to the existing university curricula as well as to the current state of education of physicists employed in hospital. The role of national society in further improvement of basic, postgraduate and additional education in medical physics was pointed out according to the evident interest for education expressed during the last decade. It was concluded that the most efficient way of achieving this could be to strengthen the cooperation among national societies, universities and other authorities with the aim to induce a reaction to refresh the existing programs and to add new subjects, analogous to the recent improvements in the developed countries.*

**Key words:** Education; Medical physics; National societies; Specialization; Curriculum

*Archive of Oncology 2000,8(2):55-9©2000, Institute of oncology Sremska Kamenica, Novi Sad, Yugoslavia*

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## INTRODUCTION

The idea to improve the conditions for better education in medical physics originates from the very beginning of established activities of Yugoslav Society for Biomedical Engineering

*Abbreviations used in text: American Association of Physicists in Medicine (AAPM); Additional Program of Professional Education (APPE); Biomedical Engineering (BE); Biomedical Engineering and Medical Physics (BEMP); Coordination Committee for Physics and Medical Physics in Yugoslavia (CCPMP); Center for Multidisciplinary Studies of University of Belgrade (CMS); European Federation of Organizations for Medical Physics (EFOMP); European Medical Radiation Learning Development (<http://www.emerald2.net>) (EMERALD); Society for Electronic, Telecommunications, Computers, Automation and Nuclear Engineering (ETRAN); European Forum for Education in Physics (EUPEN); Federal Republic of Yugoslavia (FRY); Medical Physics (MP); National Member Organization (NMO); Training and Education for Medical Physics and Engineering Reform in Europe (<http://www.inbit.gr/fine-tempere>) (TEMPERE); Yugoslav Society for Biomedical Engineering and Medical Physics (YUBEMP); Yugoslav Radiation Protection Association (YURP)*

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*The manuscript was received: 27. 12. 1999.*

*Provisionally accepted: 04. 01. 2000.*

*Accepted for publication: 10. 01. 2000.*

and Medical Physics (YUBEMP). Statute, that elaborates competency of a society in the field of education, training and accreditation program in medical physics, has been adopted during the Founder Business Meeting (Belgrade, December 1996) (1). In April 1997 the Federal Ministry of Justice officially registered the society and in September 1997 the society was confirmed as National Member Organisation (NMO) of the European federation of Organisation for Medical Physics (EFOMP).

These intensified actions are resumption of previous activities of Yugoslav Society (Yugoslav Society for Medical & Biological Engineering, that was set up in former Yugoslavia 1984), and soon after become also NMO of EFOMP. The previous society had Medical Physics Division, but with main activities devoted towards the nuclear medicine. Hospital physicists involved in radiotherapy were connected with Medical Societies of Radiology, rather routing their activities in closer collaboration with medical doctors than with physicist or engineers from related branches. On the other hand, physicists involved in radiation protection in medicine were included in activities organized by Radiation Protection Society. Thus, collaboration and experience exchanges, necessary for support in recent development of medical physics that originate from basic education, stayed without major success.

Progress in radiation medicine (radiation therapy, diagnostic radiology and nuclear med-

icine) is mainly based on the contribution from physics as fundamental science. From this point of view the need for education in this area is strongly underlined deserving cultivation of undergraduate and postgraduate level at the university, through training in the clinical practice as well as in individual continuous education. For better chance in curative effects it also becomes important for numerous patients passing through departments of radiation medicine, either for diagnostic investigation or treatment.

Existing activities in medical physics are mostly achieved through clinical implementation and practice, as well as through professional and promotional actions undertaken by national societies in physics and biomedical sciences. Available system of education, with regards to practical needs and requirements for medical physics, still does not exist in Yugoslavia.

### National society activities

Yugoslav Radiation Protection Association (YURPA) and the Coordination Committee for Physics and Medical Physics in Yugoslavia (CCPMP) used to deal with some aspects of medical physics. YURPA mainly with practical aspects of radiation protection, dosimetry and professional risk evaluation, but CCPMP proposing a joint program in physics, biophysics and medical physics on the faculties of



medicine, veterinary medicine and stomathology, both in graduate and postgraduate levels. Program was neither officially accepted nor implanted in university curricula (2, 3).

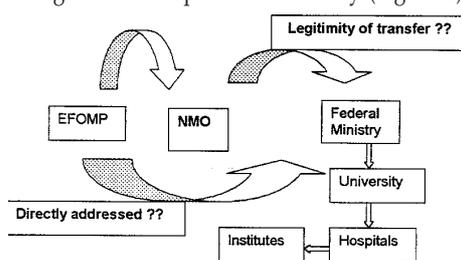
Similar efforts are continued by YUBEMP that was founded to follow, to develop and to promote biomedical engineering and medical physics (BEMP) in Yugoslavia. YUBEMP consists of 89 members (december 1999), 57 of them are involved in medical physics. Almost all hospital physicists that deal with nuclear medicine, diagnostic radiology, radiation oncology and radiation protection are society members, with very few exceptions which refused the membership. YUBEMP members, as qualified experts from different institutions should implement and adjust the available experience defining the practical needs for education and for further development in medical physics. Some important tasks of society are an on going process: to create and to participate in education and training proceses; to cooperate with other societies and universities; to organize courses, seminars, workshops, vocational schools as a part of additional education (4).

#### Cooperation with other societies

YUBEMP closely cooperates with YURPA and with the Society for Electronics, Telecommunications, Computers, Automation and Nuclear Engineering (ETRAN), working jointly with other national and international societies in exchanging experiences and distributing reports and information (5). Unfortunately, the activity success within and among societies are generally based upon professional desire, enthusiasm and personal communications of the individual members (6). The most efficient and usual contacts are achieved through meetings and conferences where societies could represent themselves activating the interest for either general or particular sub-fields of BEMP. For the purpose, the YUBEMP program has already been officially promoted in meetings of other societies (7-12).

Having the status of NMO of the EFOMP the society is included in all activities of European federation (13). That way, YUBEMP had the opportunity to participate in the EFOMP Travel award scheme and in 1998 one member of the society obtained this award. In the relation with other NMO of the EFOMP, the society was invited by the Bulgarian Society for Medical Physics to participate in the course that presented Euroatom directives in radiation protection (Plovdiv, 1998), by the Romanian Society for Medical Physics to participate in the Annual Meeting (Mamaia, 1999), and by The Hellenic Association on Medical Physics to take part in organisation of the VI International Conference in Medical Physics (Patras, 1999).

Such cooperation should result in a stronger link in similar approaches and problem resolving among all national organisations and NMO's of the EFOMP, especially from the southeastern European countries. In that way, expertise, information, programs and literature, students and lecturers, could be much more easily exchanged. The link might be the very first step that could annulate the gap that exists between developed and developing countries (14). The EFOMP should support this link with valid NMO legitimate transfer of the uniform European approaches and directives, directing them through regional Ministry of Health streight to the responsible authority (Figure 1).



**Figure 1.** Illustration of potential EFOMP directions for support of NMO in educational activities

YUBEMP made some efforts in this direction. Although the results are not yet evident, a discrete increase in interest for BEMP activities has been achieved, even at the level of Federal Ministries.

Generally, further contacts, either with the European Forum for Education in Physics (EUPEN) or with some other European projects (TEMPERE, EMERALD) for education in MP, should be among priorities, too.

#### Cooperation with universities

An important task of a national society is to co-operate with universities in the field of education as a common interest. Although, the responsibility for quality of the educational programs relies mainly on universities, as the major institution, the responsibility should be shared with national society that has some additional advanced and developed program supported by international associations.

It is not surprising that one of the major problems in European Community is in education which "besides agriculture, ... is the most conservative area of one nation culture, history, activities and prejudices" (15).

Official university education is a highly inert system with difficulties in following and updating current trends. The university program innovation requires a long administrative period to be implemented. Formal, common levels of education, recognized by national university authorities, can be summarized as a degree nominated by them, as follows: undergraduate (B.Sc.), postgraduate (MSc), specialists, doctor of

sciences (Ph.D.). University also nominates further levels, indispensable such as, for work with students, assistant, assistant professor, associate professor, and full time professor. On the other side, Ministry of science, according to criteria valorized by corresponding coefficients, nominates corresponding research degrees, necessary for work at research institutions such as: independant investigator, research consultant, high research consultant, research adviser.

However, medical physics together with biophysics and other applied branches of physics in medicine, veterinary medicine and biology in general, is still out of scope of the faculties of physics in Yugoslavia. Current physics curricula on technical and biomedical faculties incorporate poorly only some aspects and parts of medical physics. It opens the question of self-education of physicists. Even lecturers have very poor practical experience and knowledge in medical physics, biology, anatomy and physiology. There are still actual discussions concerning the postgraduate level, which are interesting for the undergraduate studies as well. Who should "lead" in MP education: "physicists or physicians" (16)?

National professional society in cooperation with universities could promptly react with flexibility of choice, both concerning the implementation of contemporary topics and provision of adequately qualified teaching staff. Also, it could easily coordinate, without administrative obstacles, among all participants in organizing additional programs.

Supported by the EFOMP to transfer European directives in the field of education, YUBEMP could contribute to the process of university curricula transformation and improvements, either through joined organised activities or by professional suggestions directed towards the government authorities. The recommendations and guidelines of American Association of Physicists in Medicine (AAPM) and the EFOMP, or an European perspective, are used in approaching education and training. This approach can be recommended, accepted and adjusted to the local conditions with the aim to set up a new approach in national skills and syllabus (17-21).

#### Additional Program of Professional Education

As an answer to the problems in question, YUBEMP created, and is continuing to improve, the Additional Program of Professional Education in MP (APPE).

The aim of the APPE is to bridge over the gap between the undergraduate program in physics and the advanced requirements in MP and their application in clinical practice in order to maximize benefit in health care area (22).

APPE structure:

- renewal: basic theoretical and practical foundation
- addendum: contemporary trends, actual international recommendation, new methods and techniques application
- practical: visiting of Institutions with presentation of equipment and following methods
- literature: written lectures with fresh references citation
- questionnaires: control of accepted knowledge
- certificate of attendance.

The program required special criteria for the teaching staff (Ph.D., 10 years experience and references in the field). The first part of APPE was realized as a course on "Monte Carlo simulations in Medical Physics", organized in 1997 in cooperation with the Faculty of Organizational Sciences of University of Belgrade. The course's output was that participants, familiar with MP learned about the usage of Monte Carlo simulation in their practical work, and the lecturers discovered new fields for implementation. The subsequent part of APPE was organized in 1998 in cooperation with the EFOMP, with support of Academy of Studenica, Institute of oncology in Sremska Kamenica and Novi Sad University. The subject of the course was "Medical Physics and Brachytherapy". The conclusions of the Round table organized during the program were as follows:

1. In its action, YUBEMP should follow the EFOMP standards and directives adjusted to the national circumstances, with regular transfer to the national government authorities, universities and hospitals.

2. YUBEMP should inform all its members about the available international schools, courses and seminars related to the subject of medical physics, to share the training benefits and to enable "in-distance" learning and personal contacts with other NMO's of the EFOMP.

3. YUBEMP should be in close contact with responsible state authorities in order to achieve approval and official recognition for its actions, as well as to make the arrangement with government for official verification and the APPE recommendation.

In order to continue the realization of APPE, YUBEMP made an agreement with the authorized Center for Permanent Education of Vinča Institute in Belgrade, to create new basic course named "Radiation Protection in Health Service". A five-day-course program consists of basic topics related to physical, biological, and technical principles of radiation protection in medicine, considering both the accidental aspects and national and international legal regulations.

In spite of the fact that the program is creat-

ed according to national law and following legislation (23), and in spite of several attempts and contacts with Federal Ministry of Health and Federal Ministry of Science requiring official program recognition, the procedure has not administratively been approved yet.

Federal Ministry of Health activated the Commission for Radiation Protection and Federal Ministry of Science the Commission for Metrology of Ionizing Radiation, to take into consideration vital aspects of radiation application in medicine, that could be considered as an important movement directed towards the recent development of unique national program. These Commissions, as influential bodies, may take over the responsibility to stimulate government administration in approving program of education for the field of national interest, as MP is.

### Education and training

The cross section of the number and the qualifications of the physicists engaged in medical physics in Yugoslavia is estimated according to YUBEMP questionnaires from 1997 (24), as well as by an independent investigation (25). All those engaged in radiation therapy (T), nuclear medicine (N), radiation diagnostics (R), magnetic resonance imaging (M), radiation protection (P), radiation dosimetry (D) and equipment maintenance engineering (E) are considered to be medical physicists. The number of physicists employed at different institutions, with qualifications according to the block scheme, are presented in Tables 1,2. Generally,

**Table 1.** Table 1. Result of YUBEMP questionnaire concerned with educational structure in medical physics (24)

	B	M	S	D	A/I	AsP/RC	AssP/HRC	P/A
H	27	1	3					
R	8	3		1				
U		1		1		1	1*	2
C	4							
O			2*	1				

Abbreviations: H-hospital, R-research institute, U-university; C-company, O-other, B-bachelors degree, S-specialization, M-master of science, D-doctor of science, A-assistant, AsP-assistant Prof., AssP-associate Prof., P-full time Prof., I-investigator, RC-research consultant, HRC-high research consultant, RA-research adviser

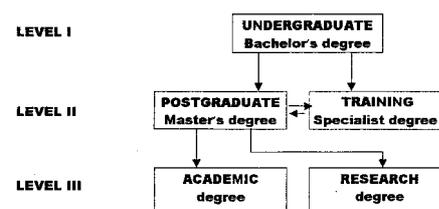
**Table 2.** Number and degree level of physicists employed in hospitals or affiliated institutions (1)

Institution	Number of physicists							Level I			Level II		Level III	
	T	R	MI	D	N	P	E	B	S	M	R	A		
TOR - Belgrade	5	-	1	-	1	1	2	7	1*	1*	1	-		
JR MMA - Belgrade	2	-	1	-	1	5	5	9	1	3*	-	1		
IO - Sr. Kamenica	4	-	-	-	2	-	2	3	3	2*	-	-		
IO - Nis	2	-	-	-	1	-	1	2	-	2*	-	-		
IO - Kragujevac	3	-	-	-	1	-	2	5	-	1*	-	-		
IO - Podgorica	2	-	-	-	1	-	-	2	1	1*	-	-		
CHC - Belgrade	-	-	-	-	3	-	1	3	1	-	-	-		
IL - Belgrade	-	1	-	1	-	1	-	1	-	2*	-	-		
SSDL - Vinča	1	3	-	3	-	3	1	2	1	4+2*	3	2		
PSDL-FBMPM	-	-	-	3	-	-	-	1	-	1*	1	-		

Note: \* denotes degree in process started after 1995.

Abbreviation: I-Institute; O-Oncology; R-Radiology; MMA-Military Medical Academy; C-Clinical; H-Hospital; C-Center; L-Labor; FBMPM-Federal Bureau for Measures and Precious Metals

education of medical physicists can be divided into three general levels of basic education network (Figure 2). Undergraduate level that refers



**Figure 2.** Block scheme diagram of existing general education levels (10)

to basic studies in physics (4 years, BSc. degree) is achieved at the Faculty of Physics of University of Novi Sad (medical physics course has been included in the 4th year, since 1997), and at the Faculty of Electrical Engineering of University of Belgrade (Nuclear Physics and Medical Nuclear Techniques have been included in the 4th year, since 1994). Biomedical Faculties (Faculties of Medicine, Stomatology and Faculty of Veterinary Medicine) incorporate MP in the basic courses of physics and/or biophysics in the 1st year, and in the courses of radiology, physical therapy, and radiation hygiene in the 5th year of basic studies (26).

Postgraduate studies, organized by the Faculty of Physics and the Faculty of Medicine of University of Novi Sad, were established in 1995. The program consists of lectures, seminars, practical and tutorial work followed by practical training in hospitals under the supervision of an experienced MP. The curricula include Physics of Human Organism, Physiology and Cell Biology; Informatics, Medical Statistics, Modeling; Medical Instrumentation, Radioisotopes in Medicine, Radiation Diagnostics and Therapy Physics, Basic course in Radiotherapy and Radiobiology. All undergraduate students coming from different faculties of natural sciences are allowed to attend these studies. Students are mostly physicists, medical doctors or engineers. They may choose among the optional courses of Magnetic Resonance Imaging, Medical Optics, Ultrasound in Medicine, Pharmacology, Lasers in Medicine, and Monte Carlo simulation (27). In spite of the attractive program, a small num-



ber of participants has passed through the course until now, and there are no defended theses so far.

Center for Multidisciplinary Studies of the University of Belgrade established a program in postgraduate studies in Biomedical Engineering (BE) in 1977, and revised the program in 1993. Although not explicit in name, it covers many aspects of MP through the courses of Ionizing Radiation in Medicine, Biomedical Signal Processing, Basic Nuclear Medicine, Artificial Intelligence in Medicine, Laser Medical Techniques and Radiation Protection. The special courses in Biomedical Engineering with written seminars provide the students the opportunity to learn more about special topics in the field directly related to MSc Thesis. Concerning the future progress in education and recent scientific development in BEMP, as well as practical needs in health care, including the research equipment development and application, the topics listed above could be further modified. At present, the program is planned and organized according to the interest and needs of the trainees as well as to the availability of the experts in the field (28). Several Master thesis in MP subjects were defended during the last few years.

Training in MP is officially recognized as a specialization<sup>1</sup> in Medical Nuclear Physics certified by the Ministry of Health of the Republic of Serbia.

The program of specialization was established in 1981 at the Faculty of Medicine of University of Belgrade (29,30), and in 1993 at Faculty of Medicine of University of Novi Sad (28). In practice, only occasional physicists engaged in radiotherapy and nuclear medicine obtained a specialist degree. This is not so unexpected, taking into account the fact that physics graduates are mainly trained in pure, and not in applied physics. Based on the available systems for postgraduate studies in medical physics (Table 3), it becomes obvious that the above

**Tabela 3.** Available system for postgraduate studies in FRY referring to MP

University	Belgrade	Belgrade	Novi Sad
Faculty	Medicine	CMS	PHYSICS
Course	Specialization in medical nuclear physics	Postgraduate course in biomedical engineering	Postgraduate course in medical physics
Program	Composed for physicists working in hospitals	Composed for engineers, physicists, medical doctors and others	Composed for physicists, medical doctors and other professionals
Teaching staff	Faculty of Medicine	all faculties and institutions	both Faculty of Physics and Medicine
Students	Physicists	Medical doctors, Physicists, others	Medical doctors, Physicists, others
Diploma	Specialist in medical nuclear physics	Master of biomedical engineering	Master of medical physics

mentioned opportunities which are offered, are not organized for physicists exclusively, thus they are not attractive for them. EUPEN is

<sup>1</sup> Specialization - brings a specific status in Yugoslavia; refers to medical doctors (specialist in internal medicine, specialist in ophthalmology, specialist in radiology, etc.) and was automatically applied to physicists working in hospitals.

presently working on a joint European program in physics university curricula, including numerous aspects of applied physics with MP as the most outstanding in that area.

However, most European countries have already organized a specialized physics core in medical physics or biophysics, including hospital experience and training. EUPEN also insists on the career aspects of physics graduates trying to increase the percentage of physicists working in the field of applied physics, industry and medical physics. EUPEN strongly recommended the cooperation among different education levels and multimedia actions (32). At the Faculty of veterinary medicine, University of Belgrade, a specialization program in Radiology and Physical Therapy (2 years) has been organized. Also, within the MSc degree studies in Radiology, courses in General and Specialized Radiology, Physical Therapy, Radiopathology and Radiotoxicology have been included (33). Since the program was held by specialists of veterinary medicine, with poor or without participation of physicists and medical physicists, such program revision was also recommended.

The changes in education of physics that the European Union recommended indicate the positive experiences of some countries in that direction. In the Czech Republic, for instance, the number of students enrolling in physics courses have increased significantly when a number of courses in the field of health and MP (nuclear energy and the environment, medical radiation physics, applied nuclear physics, radiation and dosimetry etc.) have been introduced (34,35).

How to start with it from national society's point of view?

The best way to influence the changes in the field of education in medical physics is to join efforts in applying recommendations that come from national (36) and international (37) sides.

## DISCUSSION

In the current educational system, regarding to medical physics, there is no degree that officially requires either additional education or knowledge refreshment. It is left to the professional consciousness of each individual. At the same time, it becomes important to underline the difference between the postgraduate degree recognition and the qualifications with competency and professional ability to get answers for demands of specific jobs in health care area, its realization and recent development. There are several weak points concerning the university programs, teachers' qualifications and competency, as well as the undergraduate background of postgraduate students. Equal qualifications of medical doctors and physicists, admitted with

specialist or master of science degrees in biomedical engineering and medical physics, is not the proper solution. Medical doctors could never be responsible for medical physics, and vice versa. The aim of education in medical physics is not a question that refers only to better status of employed physicists, but to expected benefit in health care area. Hospitals have to express their interest not only in formal specialisation directed to status equality, but to useful specialisation resulting in excellent knowledge in MP that following European standards, as well.

However, there is still no national authority with the competence and expressed interest to form national standard for basic and advanced education and training in MP. That once more brings up the question related to education: Which students enroll the faculties of physics? Should the physics curricula contain special courses in MP, radiology, mathematical biophysics, physical methods and instrumentation in medicine? Should all the courses be optional or not? How medical physicists should be trained for work with patients?

## CONCLUSION

From the data presented and analyzed, it is important to underline the difference existing between the postgraduate degree recognition and the qualifications with adequate competency and professional ability to answer the demands of the specific job, its realization and development. Therefore, YUBEMP APPE offers professional assistance to universities and appropriate governmental authorities to seriously consider the task of establishing a program of a uniformly certified educational program, designed specially for MP. Taking all that into account, the role of the national society in postgraduate and additional education and training of MP should be the following:

1. To promote intensive and continuous education, research and training in accordance with the international programs and recommendations, and minimising the gap in MP education and research between the advanced and countries in transition;
2. To control the training and practicing process in hospitals, or in affiliated institutions, under supervision of experienced, qualified experts;
3. To extend educational and training programs to inter-university collaboration in Eastern European countries, exchanging both students and teachers, especially in the appropriate areas;
4. To promote the establishment of official certificates for qualifications and competency in

the field of MP, issued by national societies (in Cupertino with international organisation), or by other authorised boards.

Although this paper does not deal with the narrow, oncological topic, the Editorial office decided to print it in this number of Archive of oncology, with respect to its worth, and because of the fact that the role of medical physicists is extremely important in oncological facilities.

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