Medical Imaging and Radiation Therapy in Croatia

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Abstract

An overview of the medical imaging and radiation therapy in Croatia is presented in the context of the new postgraduate specialistic study of medical physics at the University of Zagreb.

Introduction

Medical imaging and radiation therapy have a long history in Croatia. Due to the existence of the Zagreb cyclotron in the past, a number of radioisotopes were available for medical applications too. These isotopes were used together with gamma cameras starting for example the original pioneering studies of the lung ventilation diagnostics in Croatia. Also, jointly with doctors of medicine Zagreb physicists have contributed to the development of the ultrasound diagnostics during the maternity process. In time, the financially strong instrument producers took over the development part of the field but the application of these large instruments still requires the expertise of the medical physicist. Within the medical practice in Croatia the following modern physical techniques are in use now:

Ultrasound Imaging (Color –Doppler included)
Magnetic Resonance Imaging
Imaging with Radioactive Tracers (PET included)
Radiotherapy (Cobalt sources and accelerator produced radiation)
Gamma-knife Surgery

The new curriculum was developed at the postgraduate level within the University of Zagreb serving the three basic aims.

a) Broadening the standard undergraduate basic knowledge of the physical processes required within the medical physics.
b) Supplying the physicist with those aspects of medicine which are necessary for the application of physics in medicine.
c) Securing that the person educated within the standards of physical sciences accepts the specific responsibilities within the public health institutions.

Curriculum of the new postgraduate degree: Specialist Medical Physicist

In addition to the existing Mr.Sc. program in Medical Physics at the University of Zagreb which is composed along the traditional academic lines of the physicist profession the new curriculum has been developed complementing the basic physicist's knowledge with those practical aspects which are necessary for the successful inclusion of the physicist into the hospital reality (items b) and c) above). In *Table 1.* we list the courses included in the new postgraduate program at the University of Zagreb. The *Table1.* contains both: the core (obligatory) and the elective courses. The candidate must acquire 140 credit points in the first two years of study.

THE CORE SUBJECTS IN THE SPECIALISTIC STUDY OF MEDICAL PHYSICS

SUBJECT	LECTURES	EXCERSIZES	CREDIT
Physics in Radiology and Radiotherapy	30	15	20
Physical Aspects of Nuclear Medicine	30	15	20
Physics and Techniques of Ultrasound	30	15	20
Dosimetry and Radiation Protection	30	15	20
Imaging Techniques in Medical Physics	30	15	20
Biomedical Electronics/Instrumentation	30	15	20
Selected Chapters of Radiological & Functional Anatomy	30	15	20
Selected Chapters of Physiology/Pathophysiology	30	15	20
Seminar in Medical Physics	30	0	5

THE ELECTIVE SUBJECTS

SUBJECT	LECTURES	EXCERSIZES	CREDIT
Numerical Methods and Mathematical Modeling	30	15	18
Magnetic Resonance	15	15	15
Selected Chapters of Oncology and Radiotherapy	15	15	10
Use of Laser in Medicine	20	15	15

Table 1. Courses for the first two years of the new postgraduate study of Medical Physics in Croatia.

During the first two years the candidate is also required to have in-the-job specialistic (practical) training at the University Hospitals. The list of those subjects together with earned credits is in the *Table 2*. In fact this practical training extends for two additional years bringing the practical training to the total period of four years.

FIELDS OF SPECIALISTIC TRAINING DURING ALL FOUR YEARS

FIELD	CREDIT
Diagnostic Radiology (Roentgen, CT)	15
Radiotherapy (Cobalt, Linac, Simulator, Absolute-Relative-In Vivo Dosimetry	30
Nuclear Medicine (Radioisotopes, SPECT, PET, Gamma Scintillation Detector	30
Ultrasound in Diagnostics and Therapy	20
Radiation Protection	10
Magnetic Resonance	10
Laser Applications in Medicine	10
Thermography	10
Measurements of Bioelectric Signals	10
Electrostimulators	10

Table 2. Credits for Specialistic Training during the four years period.

The total number of earned credit points including the courses and the specialistic training required for the degree is at least 240. With this result the candidate is awarded the title of MASTER OF MEDICAL PHYSICS which corresponds to the European Federation of Organizations for Medical Physics (EFOMP) standard: THE QUALIFIED MEDICAL PHYSICIST.

Continuing Professional Development and Education

Further professional improvement and education follows through various activities listed in Table 3. These activities are integrated over the whole specialistic training and beyond. They keep the professional updated on the new developments and help the information transfer within the medical physicists community and wider.

CREDITS IN CONTINUING PROFESSIONAL DEVELOPMENT AND EDUCATION

	CREDIT POINTS
Delivery of the Lecture at the Scientific Meeting	10/Lecture
Organization of Congresses, Seminars and Workshops	10/Event
Clinical Educational Activities/Lectures to the Staff	5/Hour
Attendance of Congresses, Seminars, Workshops	2/Course
Attendance of the International Educational Courses (Field of Specialization)	up to 30/Course
Educational Lectures to the Hospital Technicians and Nurses	1/Hour
Short Visits to other Departments for the Special Training	5/Visit
Publication in the Scientific Journal (depending on the type of Journal/Event)	up to 30
Publication in the Textbook (depending on size)	up to 30
Implementation of new Technologies/Procedures Related to the Medical Physics	up to 20

Table 3. Continuing Professional Development and Education Credits

When the total of credit points from the *Table 3*. reaches 100 with the average of 25 per year, the candidate is eligible for the FINAL SPECIALISTIC EXAM . This enables one to reach the title: THE SPECIALIST MEDICAL PHYSICIST. Concluding this presentation of the new postgraduate project at the University of Zagreb one can state that a strong professional effort of the physicists' community combined with University support has been made to bring the basic knowledge of the physicists into service of the general society.

Example of Physicists Working Area in Clinical Environment

In order to illustrate the above scheme we describe one particular aspect in the practicing component of the project. Of course the entire project contains very many analogous facets. For that purpose we examine the role of the medical physicist in the procedure of the Bone Marrow Transplantation (BMT). Prior to BMT, in the procedure of preparation of patient, a high absorbed dose during the Total Body Irradiation (TBI) is recommended. The applied dose must be as homogeneous as possible (variations of only 10%). This requirement is not easy to achieve. The special care must be taken e.g. about the lung irradiation, where the overdose might have fatal consequences. The principal parts of the procedure related to the physicists work are:

1) The equipment used in the irradiation must be carefully adjusted to the TBI geometry. This includes large distances securing the large radiation fields, low dose rate, spatial limitations and the sophisticated dosimetry system

2) It is preferred to perform the initial broad beam photon measurements and radiation field analysis with the use of the automatic dosimetry system applied on the phantom of real dimensions.

3) The mathematical model of TBI including the physical irradiation conditions, prescribed geometry and phantom's position must be constructed in such a way that the model's predictions are close to the experimental results.

4) After this an extrapolation of the model results are made to various human dimensions met in reality. This enables the continuous monitoring of the irradiation dose by detectors fixed onto the patients skin during the treatment. This allows for the corrections of the irradiation time, or eventually, interruption of the TBI if needed.

5) Intercomparisons with the results and methods in other centres/countries also are included.

We have included this example to emphasize the component in the work of the medical physicist which requires the close collaboration with the medical doctors and shows directly that the physicist in hospital is also the medical worker. Similar examples can be made in other topics: diagnostic radiology, nuclear medicine, nonionizing irradiations (ultrasound, laser), physiological measurements in cardiology, neurology etc.

Conclusion

Medical physicist as a profession in Croatia is a challenging activity. The new postgraduate study at the University of Zagreb ensures not only that the major novel scientific achievements are included into the curriculum, it also incorporates, for the first time in Croatia, components which complement the traditional physicists education with the practical experiences needed for the successful presence within the hospitals.