HUNGARIAN MEDICAL PHYSICS MSC EDUCATION

D. Légrády[1], Cs. Pesznyák[1,2*], Sz. Czifrus[1], P. Zaránd[1], T. Major[2], A. Aszódi[1] [1]*Budapest University of Technology and Economics, Institute of Nuclear Techniques, Budapest, Hungary;* [2]*National Institute of Oncology, Budapest, Hungary*

Abstract

The medical physics specialisation aims at providing high level interdisciplinary theoretical and practical knowledge and readily applicable skills, which can put into action in both the clinical and the R&D field. The first competence based gradual medical physics course in the B.Sc./M.Sc. system in Hungary was launched two years ago at the Faculty of Natural Sciences of Budapest University of Technology and Economicsmanaged by the Institute of Nuclear Techniques. The MSc programme was compiled on the base of EFOMP, IPEM, AAPM and IAEA recommendations. The course curriculum comprises fundamental physical subjects (atomic and molecular physics, nuclear physics and particle physics) as well as fundamental medical knowledge (anatomy, physiology and radiobiology) required for subjects of diagnostic and therapy. Students of this MSc branch may chose further subjects from a "compulsory optional" set of subjects, which contains medical imaging, X-ray diagnostics, radiation therapy, magnetic resonance imaging, radiation protection, Monte Carlo calculation and its clinical applications, ultrasound diagnostics and nuclear medicine.

Introduction

Following a two year organization effort, a Medical Physics (MP) specialization to the Physics MSc was launched during the autumn semester of 2010 at the Budapest University of Technology and Economics (BME). In May 2012, eleven students graduated successfully, with comparable number of students starting in 2011 and 2012. As the field must comply with medical legislations and keep up with the sprouting new technologies, competence-based education required close cooperation with stakeholders such as hospitals, clinics, medical care providers, preclinical research centres, medical equipment developing companies and vendors.

[*] Presenting author: *pesznyak@reak.bme.hu*

Conditions at the initiation and historical prepositions

Background for high competence levels in Medical Physics was never amiss in Hungary, with a still existing radiation oncology centres dating back as early as thirties and nuclear medical instrumentation development at Gamma Művek producing gamma cameras since the 70's.The Hungarian Association of Medical Physicists as the Hungarian member society of EFOMP is entitled to prepare the Training Scheme, and has appointed a Training and Education Committee to administer the Training Scheme in 1996 [1]. In accordance, organizing formal gradual education was first pursued by our co-author Pál Zaránd by developing a later EFOMP-approved (1998) curriculum [2] and achieving the launch of a MP specialization to the newly initiated Biomedical Engineering 'gradual as a second degree' education of the Faculty of Electrical Engineering of BME as a joint program of three universities: BME, Semmelweis University of Medicine, and University of Veterinary Sciences. It was the first high-level comprehensive education form in Hungary that granted an MSc in Biomedical Engineering [3]. At that time Hungary used the German system of education (e.g., an MSc in physics being equivalent with Diplom Physiker). Therefore, some medical courses started during the last two semesters of education followed by four additional full semesters usually sponsored by companies. The program successfully achieved congregating lecturers for most MP topics but almost all the specific field experts were invited lecturers and an independent competence base did not build up in its wake. After having a few students trained, the medical physics specialisation ceased also due to the lack of company funding [4,5].

Initiated by the Bologna process in higher education changing to the dual system of BSc and MSC programs and also in an attempt to find more closely connected competencies, the Faculty of Natural Sciences of BME offered to host the MP education at the Institute of Nuclear Techniques (NTI). This institute had originally nuclear reactor oriented education with broad radiation physics expertise ranging from instrumentation and measurement techniques through radiation protection to particle transport calculations but severely lacking medical applications.

The above education programme was tailored to accommodate conditions given or since then emerged such as the Bologna process that required the cross-country unification of MSc programmes, and the resulting educational legislation prescribed "medical physics" to be a part of the Physics MSc education; or further the achieved competences had to be broadened to also fulfil the human resource needs of medical R&D companies gaining more and more momentum in Hungary. A further bounding condition was raised by the medical legislation requirement for experts with hands-on training in radiation therapy for which the necessary theoretical knowledge must be provided. Unfortunately legislation still does not require the presence of MP experts in diagnostics hindering the development of a fully functioning quality control culture.

Building a competence base

Delivering competence based education first of all requires a strong competence base. For gaining up-to-date information on job market demands, stakeholders were surveyed to name the necessary competences let that be clinical institutions, vendors or R&D companies. The lack of a formal education showed in the ambiguity of the answers while during the past two years of educational and research collaborations with the same stakeholders increased the level of certainty of the demands and raised the confidence in the competence of the students, leading to a conclusion that developing a competence base improves the competence of the stakeholders in turn when they have learned that high level, up-to-date and field-specific knowledge can really be conveyed.

Building the high level competence was achieved by a strategy of selecting for each MP subtopic (Radiation therapy (RT), MRI, Nuclear Medicine, X-ray, Ultrasound etc.):

- a theoretical expert, a lecturer employed by NTI with research field closely related to acquire the necessary knowledge;
- a medical institution making use of the technique in question;
- a company (R&D or vendor) providing necessary insight into the state-of-the-art even regarding technological details.

As RT always requires special attention and a very close connection to the clinical environment, part time employment of an RT expert was offered to an clinical medical physicist with academic background as a lecturer to invite RT competence to the NTI while keeping up the connection – by keeping daily involvement in RT work – to the clinical world. At the end about half to two third of the lectures and practices are given by and at NTI, the rest covered by invited lecturers, at clinical, industrial or licensing authorities.Medical courses such as anatomy and medical physiology are given by lecturers from the Semmelweis Universityof Medicine.

Curriculum

Physics MSc is a 120 credit (conforming to ECTS) programme, 30 credits are allocated for core physics studies involving subjects such as atomic, molecular and nuclear physics, here also a 6 credit worth special laboratory is included specialized to MP; further 10 credits are allocated for general subjects, 50 credits are given for research work leading to the Master's thesis and finally 30 credits are fully specific to the MP specialization. Educational legislation prescribes 10 credits to be allocated for "medical biology and physiology", and further 16 to therapy and diagnostics. Available MP specialized subjects are (with theoretical credits / practical credits, in parenthesis, respectively) Functional Anatomy (2/2), Physiology (3/1), Ethics in Medical Research (2/2), Radiobiology (2/1), Physics of Radiotherapy (2/2), Radiotherapy II. (2/0), Radiation Protection in Medical Physics (3/1), Brachytherapy (2/0), Quality Control and Legislation Issues (2/1), Medical Imaging (3/1), X-ray diagnostics (2/1), Nuclear Medicine (2/1), Magnetic Resonance Imaging (2/1), Ultrasound diagnostics (2/0). Further subjects to select are related to various lectures on Optics and on Monte Carlo methods. Module of Specific Lectures is collected on the base of IPEM, EFOMP, AAPM and IAEA recommendations [6].

Skills development and a competency oriented approach

Commonly, universities are seen as knowledge centres as opposed to skill or competence bases. As our MP education is hosted by a university of technology, emphasis on skills is not out of tradition; moreover physics students complain that during their BSc and MSc times they are obliged to carry out above 160 different laboratory exercises. In our case, venturing into the more vocational domain of training, aiming at reaching competence is a must given the two safety hazardous factors: the medical and the nuclear aspects. The latter field struggled to introduce 'attitudes' amongst competence factors, putting emphasis on radiation safety culture. Patient treatment legislation is left for an also newly instated post-gradual education of "Clinical Radiation Physicist" organized by medical universities, though our students are obliged to carry out full RT planning until the point of actually treating a patient and also in QA/QC until the point of assessing an equipment without the right of formal approval. Regarding nuclear safety culture national qualification of the 2nd level (being 3rd the highest) can be obtained based on the regular radiation protection lectures with an extra exam requiring the presence of a nuclear safety authority examiner.

Teaching up-to-date skills and competencies heavily need access to state of the art instrumentation. As the MP education was initiated by the enthusiasm of the field experts and a foreseen qualified workforce shortage rather than a push from a governmental initiative, stakeholders were approached for donations of equipment and/or equipment time, and a very limited institute budget was also allocated for this purpose. Institutes and companies that are involved in the process: National Institute of Oncology, BME Institute of Physics, "Frédéric

Joliot-Curie" National Research Institute for Radiobiology and Radiation Hygiene, Semmelweis University, University of Debrecen, HAS ATOMKI Institute of Nuclear Research, Mediso Ltd., GE Healthcare Hungary, Richter Gedeon Plc., Siemens Health Hungary Ltd., Varian Medical Systems Hungary Ltd., PTW Freiburg Ltd., Canberra-Packard Ltd, SUN Nuclear, Fototronic Ltd., Pozitron-Diagnosztika Health Centre**.** Further equipment was developed using the institute's nuclear instrumentation stock. The most specific 6 credit worth (14 x 6 hours) laboratory practices include amongst others dosimetric measurements with linear accelerators radiation treatment planning with VARIAN Eclipse and Philips ADAC Pinnacle and QA/QC based on the IAEA-TECDOC-1583 with Cirs IMRT Thorax phantom, brachytherapy I-125 seed prostate treatment; working with a Mo-Tc generator and including handling activities above 100 MBq in liquid form, measuring with a thyroid gamma-camera; working with a preclinical 33 by 33 crystal PET module, exercising nuclear instrumentation with various coincidence measurements, single-pixel transmission gamma tomography using collimators and consequent filtered backprojection image reconstruction, thin layer chromatography for PET isotopes, ultrasound, brachytherapy, just to name a few. A full list of lab exercises can be found in our website [7]. Most of the needed instrumentation is donated to the institute and more than half of them can be carried out in-house. The effort is ongoing to grow the independence of these measurement exercises from outside institutes as much as possible. This effort is aided by a non-MP specific EU laboratory funding offered for use for MP instrumentation by the faculty. As a result new MP equipment is expected to arrive in autumn 2012, including radiochromic film dosimetry, gel dosimetry, workstations, demonstrational MRI and Ultrasound equipment, RT and ultrasound phantoms and a preclinical small animal CT and further preclinical PET modules.

Present state and outlook

The first group of students of the MP specialization graduated successfully in May 2012. Out of these 11 students 5 started MP PhD studies: 3 in the RT field, 1 in MRI and 1 in dosimetry. A further student starts PhD studies in Nuclear Medicine. In the lower years 10 students are expected to graduate in the 2012/2013 school year, 8 new students are admitted for the 1st year.

The list of further goals to achieve starts with raising international awareness of our education. International educational and research cooperation must be joined or initiated for assuring long term quality, professional and financial sustainability, and for developing the specialisation further. With the stabilization of the specialization the scope of education is envisaged to be broadened with education and trainings for physicians, and with general dosimetry education and training. It is also planned to offer the gathered equipment and training potential in a regional scope.

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