High Education in Biomedical Engineering in Republic of Moldova

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Abstract— **The ubiquitous aspiration to health and life propels healthcare industry as the world's biggest industrial sector. Biomedical engineering (BME) occupies a central place in healthcare industry and it is one of the few areas of engineering that, as a whole, is expected to continue to grow for many years. In Republic of Moldova considering the need to prepare of specialists in Biomedical Engineering field, since 2005 "Biomedical Systems Engineering" specialty was created, which provides the basic and specialized training of specialists in biomedical engineering field, and since 2010 master's studies have been launched in this field. Two universities, Technical University of Moldova and State University of Medicine and Pharmacy currently participate in a TEMPUS IV project "Biomedical Engineering Education Tempus Initiative in Eastern Neighboring Area" (BME-ENA) with a main objective the Master educational program creation and harmonization in field of Biomedical Engineering and elaboration of a new curriculum for Master studies in Moldova.**

Keywords— **biomedical engineering, medical devices management, healthcare industry, education, licentiate's studies, master's studies.**

I. Introduction

The worldwide medical devices industry with a turnover of over 226 billion dollars in 2011 will reach a volume of over 434 billion dollars in 2017, with a growth rate of 7.1% per year: it is one of the few areas that is expected to grow continuously for long while. The medical devices industry includes 13600 registered manufacturers, about 10000 generic devices and over 500000 products and brands.[1,2]

Today about 50% of all treatment and diagnostic used methods did not exist 10 years ago. Biomedical Engineering (BME) occupies a central place in healthcare industry and it is one of the few areas of engineering that, as a whole, is expected to continue to grow for many years. The US Bureau of Labor Statistics projects a 21 percent growth for biomedical engineers, with an estimated of 15,000 new careers created in the industry through 2018 [3].

At present the Health System in Republic of Moldova includes 912 medical institutions of which 278 public medical institutions (59 hospitals with 19840 beds), in which 12 794 doctors and 27 407 medical staff with secondary education operate. The degree of medical devices wear is high both in rayon and republican institutions.

The evaluation of global experience in the field demonstrated that the advanced medical devices are an indispensable part of the medical act in the prevention, correct diagnosis and treatment of diseases that take the first positions in the mortality and morbidity structure.

Medical devices management has become a priority in health policy of many countries, many studies proving that by coherent policies in this field, the improve of the cost / efficiency rapport of advanced medical technology use, advance of patient safety and not least, increase the quality of the medical act, were obtained. The degree of endowment of medical institutions with medical devices / performing apparatus and ensuring of an appropriate level of professionalism of medical staff are key tools in ensuring the proper functioning of the health system and exert a direct impact on the operational effectiveness of the system, on the quality of service and satisfaction degree of the beneficiary.

II. Higher education in republic of moldova

The higher education in Republic of Moldova, except for medical and pharmaceutical education, is realized in two cycles:

- The first cycle – the Licentiate's higher studies with a duration of studies 3-4 years contains 60 credits for one year of study;
- The second cycle – the Master's higher studies with a duration of studies 1-2 years contains 60-90-120 study credits.
- The third cycle – the Doctor's higher studies with a duration of studies 3-4 years.

In Republic of Moldova 31 universities (17 public and 14 private) activate, whereon about 100 000 students study.

III. High education in biomedical engineering in republic of moldova

A. *Licentiate's Studies*

Considering the need to prepare of specialists in Biomedical Engineering field, since 2005, at the insistence of the Ministry of Health and Technical University of Moldova, "Biomedical Systems Engineering" specialty was included in Fields and Specialties Nomenclature in higher education to I cycle – license which provides fundamental training for qualified specialists in the biomedical engineering field, strictly necessary for Republic of Moldova. The duration of studies is four years, with 240 ECTS credits allocated.

The training of specialists provides familiarization with the following courses: *Fundamental*: Theory of Probability and Information, Electrotechnics, Data Structures and Algorithms, Numerical Methods, Anatomy, Biochemistry and Human physiology, etc.; *Specialized:* Basic Electronics, Electronic Measurements, Computer Architecture, C++ Programming, Medical Electronics, etc.; *Optional*: Microprocessors, Modelling of Biomedical Systems, Transducers and Biosensors, Medical Image and Signal processing, etc.; *Social-Humanitarian*: Philosophy; Economic Theories; Human Resource Management, Marketing, etc.; *General*: The Genesis of the state and laws; Foreign language, etc.

Fields of Activity of the Alumni: Organizing and execution of diagnostic research, treatment procedures including (rehabilitation and recovery); Health technology management; Development, production, maintenance, monitoring and diagnostic of modern biomedical equipment; Development and implementation of new medical technology using computerized means; Development, implementation and maintenance of the professional oriented informational systems; Telemedicine, telecommunication, digital communications and informational networks.

The training of specialists is carried out in cooperation with State University of Medicine and Pharmacy "Nicolae Testemitanu" from Republic of Moldova, which is responsible for the medical disciplines.

B. *Master's Studies*

The Master's Studies in "Biomedical Engineering" field in Republic of Moldova were starters in 2010. Also the training of specialists is carried out in cooperation with State University of Medicine and Pharmacy "Nicolae Testemitanu" from Republic of Moldova, which is responsible for the medical disciplines.

Taking into consideration the objectives of TEMPUS IV project "Biomedical Engineering Education Tempus Initiative in Eastern Neighboring Area" (BME-ENA) about the Master educational program creation and harmonization in field of Biomedical Engineering, a new curriculum for Master studies in Moldova, is elaborated.

The Formative Master Program in Biomedical Engineering (1.5 years, 90 credits) ensures training of specialists that are able to integrate into modern medical environment and who, together with the medical corps to contribute to the improvement of medical act or research in medical field, training of specialists with high professional competence, able to work in research, design and healthcare industry. The Master's Studies in "Biomedical Engineering" are addressed to graduates of university long standing or license studies (from the fields: engineering sciences, health, natural sciences, exact sciences, etc.) who receive a professional training in clinical biomedical engineering.

The educational program includes disciplines in science and engineering and biomedical engineering: functional anatomy and physiology, medical biophysics, Advanced Programming, Biomedical signals and images processing, Medical imaging, Radiation protection and nuclear security, Research and project management, Dedicated electronic systems, Biomaterials and Biocompatibility, Biomedical instrumentation and sensors, Medical Technology Management, Diagnostic & Therapeutical Methods, Information technologies in medicine. Master studies are divided in three semesters, I-II semester – for theoretical studies, III – practice and elaboration and defending of the Master project thesis. Every semester continues 15 weeks, and in every week students learn 6 disciplines, to each of it corresponds 5 credits.

In every semester the master students perform theses and concrete projects related to technologies that creates and implements ways to execute various tasks such as designing of various biomedical systems, new technologies of signal processing in specialized circuits, etc. The studies end with a master's thesis with applicative or scientific character.

After finishing of Master's studies, the graduates can work in the fields: Research and development of new methods and biomedical devices; Designing components, processes or systems for biomedical engineering; processing biomedical information, development and use of medical data, expert data, monitoring systems, modern applied software packages for the information, support for diagnostic and treatment process; Implementation of the background in the field of biotechnologies, biomaterials, biomechanics, biomedical instrumentation as a modern mean of applied engineering in medicine; Optimizing the use of biomedical technology in healthcare facility; Conceive and coordinate experiments in the biomedical

domain as well as the privilege of analysis and interpretation of the obtained results.

Within the Project will be elaborated educational didactic support and would be consolidated educational capacitates of professors and students. Will be created inter-university network in field of Biomedical Engineering.

Within the framework of project BME-ENA and with addition support will be created a laboratory for Biomedical Engineering, which will become National Center for Biomedical Engineering responsible for high-education and post-graduate in Biomedical Engineering.

IV. Promotion of bme education

The promotion of education in BME field is carried out by the creation of the Pilot-Center „Health Technology Management" at Public Health Institution Institute of Scientific Research in the field of Mother and Child Healthcare and Common department with the Public Health Institution National Scientific and Practice Center of Emergency Medicine.

Aims of the Pilot-Center „Health Technology Management": Support and dissemination of the biomedical engineering as a specialty and science, the aftermath being the rise of life quality as well as the efficiency of social and economic activities; Development and enhancing procedure models for the medical device management according to international standards; Promotion of the biomedical engineer major in national healthcare system correlated to the requirements and quality standards of the medical act; Boosting efficient technologies and standards in the field of biomedical engineering; Continuous professional training of the specialists (reforming teaching staff);

The Researches in Biomedical Engineering have an important role in which students are involved, for example a number of international scientific projects are achieved at the chair: Moldovan-Swiss Projects: "Regionalization of the Emergent Pediatric Services and Intensive Therapy (REPSIT)", "Modernizing Perinatal Systems (PERIN Trainings, HTM development"; FP7 Project MOLD-ERA „Preparation for Moldova's integration into the European Research Area and into the Community R&D Framework Programs on the basis of scientific excellence" (The summer school in Nano-Bioengineering, Biomaterials and Biocompatibility in 2011, 2012 and Advanced studies in Nano-Bioengineering, Biomaterials and Biocompatibility (2011-2012, 2012-2013)); Bilateral Project "Development of methods for controlled influence of light on biological tissues in relation to phototherapy"; National Projects "Development of the devices for recording and processing photoplethysmograms", "Development of the device for recording and analysis of the heart rate variability", "Devices and electronic complex systems for the monitoring and diagnostic in medicine".

V. Conclusions

There is a critical need in the market to ensure that the modern health technologies are managed by IBM professionals in order to achieve safe and effective use of medical devices. Being aware of this need, two partners (Technical University of Moldova and State University of Medicine and Pharmacy) from Republic of Moldova are very motivated to promote biomedical engineering education by establishing of the new programs of higher education in BME.

This aim will be also achieved by the TEMPUS IV project "Biomedical Engineering Education Tempus Initiative in Eastern Neighbouring Area" (BME-ENA), Project number: 543904-TEMPUS-1-2013-1-GR-TEMPUS-JPCR. Within this project will be carried out knowledge transfer between universities and institutions from the EU to partner countries from ENA (Moldova, Armenia, Georgia and Ukraine). In this way appears the opportunity to benefit from the exchange of experience using a bottom-up approach in the modernization and reform of postgraduate studies at the university level. For example, a stronger link will be establish between the two above mentioned Moldavian universities and Grigore T. Popa University of Medicine and Pharmacy from Iasi, Romania, through its Faculty of Medical Bioengineering, in order to deepen our traditional collaboration in BME domain.

As a result the BME educational structures in Republic of Moldova will be reviewed and adapted to new requirements, and the new postgraduate programs will be generated in accordance with European policy.

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Conflict of Interest

The authors declare that they have no conflict of interest.

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