

MEDICINOS ISTORIJA IR RAIDA

Biomedical physics in continuing medical education: an analysis of learning needs

Ričardas Rotomskis, Violeta Karenauskaitė¹, Aistė Balžekienė²

Institute of Oncology, ¹Faculty of Physics, Vilnius University,

²Faculty of Social Sciences, Kaunas University of Technology, Lithuania

Key words: *biomedical physics; continuing medical education; medical professionals; qualification improvement.*

Summary. *Objective. To examine the learning and practice needs of medical professionals in the field of continuing education of biomedical physics in Lithuania.*

Material and methods. The study was based on a questionnaire survey of 309 medical professionals throughout Lithuania, 3 focus group discussions, and 18 interviews with medical and physics experts.

Results. The study showed that medical professionals lack knowledge of physics: only 15.1% of the respondents admitted that they had enough knowledge in biomedical physics to understand the functioning of the medical devices that they used, and 7.5% of respondents indicated that they had enough knowledge to understand and adopt medical devices of the new generation. Physics knowledge was valued more highly by medical professionals with scientific degrees. As regards continuing medical education, it was revealed that personal motivation (88.7%) and responsibility for patients (44.3%) were the most important motives for upgrading competencies, whereas workload (65.4%) and financial limits (45.3%) were the main obstacles. The most popular teaching methods were those based on practical work (78.9%), and the least popular was project work (27.8%).

Conclusions. The study revealed that biomedical physics knowledge was needed in both specializations and practical work, and the most important factor for determining its need was professional aspirations. Medical professionals' understanding of medical devices, especially those of the new generation, is essentially functional in nature. Professional upgrading courses contain only fragmented biomedical physics content, and new courses should be developed jointly by experts in physics and medicine to meet the specialized needs of medical professionals.

Introduction

The end of the 20th century was a time of tremendous pace in technical and research progress, and today this knowledge is more and more focused on serving our everyday health needs. Understanding that the sustainable development of a society requires a strong health care system, many authors around the world have paid a great deal of attention to medical education reforms and international standards, and to the quality of medical studies at all levels and its improvement (1–8).

New methods and devices in biomedical diagnostics and treatment play an increasingly important role every day and frequently lie within the domain of

science. Therefore, medical students and professionals have to become more familiar with science knowledge and methods in order to participate in the future development of their field. Currently, health care institutions employ numerous modern devices, and modern methods based on the fundamental knowledge of the natural sciences (especially physics) are used for diagnostics and treatment. To understand physiological processes in living organisms, to handle new medical devices, and to apply new treatment methodology and methods in everyday practice, versatile knowledge in physics becomes still more necessary. Furthermore, these questions are directly related to the important issue of patient and occupational safety.

At the very least, a basic understanding of the physics involved in the functioning of medical devices is essential for medical professionals to use them safely (9–11); several EU directives, binding on all member states, deal with this important issue as well as with safety from physical agents and personal protective equipment (12–15). For these reasons, the role of biomedical physics educators takes on greater importance due to their strong competency in the safe, effective, and efficient use of medical devices (16).

Consequently, while it is clearly not possible to be fully trained in both medicine and physics, medical professionals at all levels (physicians, nurses, residents, and others) need physics knowledge even though in health care institutions in the majority of countries they work together with medical physicists. It is important that the medical professionals and medical physicists understand each other in their common work, and it is in the patients' interest that medical professionals possess sufficient technical vocabulary to be able to communicate more effectively with physical scientists and engineers.

In this regard, the World Federation for Medical Education (WFME), when considering the specifics of education programs, clearly states in its global standards for medical education (1) that the fundamentals of biomedical sciences must be included in basic medical education in order to create an understanding of the scientific knowledge, concepts, and methods essential to acquiring and applying clinical science (2, 4, 6). One of these sciences is physics. This and other medical education documents and training programs show a movement toward competency-based education, with such competencies as analytical and critical thinking etc. Authors increasingly affirm the importance of the basic sciences in medical education, for example in the context of parallels between professional competencies in medicine and science (17), of medical students' professionalism (18), of the importance of science and its place in the undergraduate medical curriculum (19–22).

Therefore, the medical curriculum must be updated with new knowledge in these sciences, to create a basis for learning and understanding new treatment and diagnostic methods and devices. On the other hand, the scope of knowledge necessary for medical professionals is constantly expanding, whereas the physical opportunities for individuals to master new information remain almost the same. The application of information technologies in the teaching process opens broad opportunities and makes it possible to

increase the efficiency of studies: time for the performance of tasks becomes shorter; much more numerous and various tasks can be performed during practical sessions. Consequently, we share the opinion of many educators and researchers that one of the solutions is continuing medical education using information technologies that make it possible to learn at a convenient time and place (7, 8, 23).

This situation also concerns Lithuania, where, following independence, changes were introduced into the health care and higher education sectors in order to improve the quality of medical studies. The reforms followed the concept of European integration, building on the European experience in modernizing study programs. They introduced new subjects into the medical curriculum, but also reduced the time available for effectively assimilating the necessary basic science knowledge, especially seriously in the case of physics. For the last two decades, Vilnius University (Lithuania) has been experiencing an obvious decrease in the physics lecturing time allocated to medical study programs: from 246 hours in 1980 to 48 hours in 2001 (still in force today) with the result that our medical professionals do not have enough basic biomedical physics knowledge. The situation is however somewhat better at Kaunas University of Medicine where the physics lecturing time allocated to medical study programs ranges from 60 to 90 hours, although the content is similar in both the universities.

The authors of this article earlier evaluated biomedical physics content and curricula in medicine study programs in Lithuania, highlighted problems (including the time question), and suggested new approaches and strategies to physics teaching and learning in medical education (24, 25). Vilnius University has implemented two pilot projects "Medphys-train" and "Dicort" supported by the EU Leonardo da Vinci program (<http://www.ff.vu.lt/leonardo>). These projects were aimed at improving the quality of biomedical physics instruction for medical students at all levels: reorganizing training in the biomedical physics courses, developing redesigned, harmonized programs of biomedical physics for all-level trainees, and creating new products for teaching and learning (for traditional and e-learning environments).

Supported by the European Union Structural funds, the project "Realization of Medical Physics and Nanophotonics Studies" aimed to create physics and nanomedicine teaching and learning materials (most of them in e-learning environments) for higher-level medical students (PhD, residents) and medical

professionals. These materials focus on new methods and devices in medicine based on physics knowledge and should, together with other project outputs, improve the quality of high-level graduate and continuing medical education. In our developmental work, we also followed the findings and recommendations of studies dealing with continuing medical education (26, 27).

A study was undertaken to examine the learning and practice needs of medical professionals in order to give direction to the creation of project materials, as suggested by Miller et al. (23). It was focused in particular on the perceptions and needs of the medical professionals in the area of biomedical physics and examined in greater detail the point of view of the medical professional and the higher-level medical student as to the place of physics in medicine, and whether their attitudes are consistent with those of physicists. A common understanding between physicists and medical professionals in this area is fundamental to improving the quality of continuing medical studies.

This article presents the results of the study according to the following main research areas:

- *the needs of medical professionals for knowledge of biomedical physics and for practical skills* using medical methods and devices,
- *the possibilities for, and obstacles to, the improvement of competencies* in biomedical physics education and *acceptable forms* of gaining knowledge in this field.

Methods

The study presented in this paper used an approach combining qualitative and quantitative research methods. The study was conducted from October to December 2007. The study methods, sample sizes, and main goals of each stage are presented in Table 1.

Purposive sampling was used to represent various levels of medical personnel and various medical institutions. In purposive sampling, the study subjects are selected based on specific characteristics determined by study goals (28). The sampling characteristics of our study were as follows: various health care professions, holders/nonholders of scientific degrees¹, researchers and practitioners, variety of medical institutions.

In total, 309 medical professionals (doctors, PhD students, residents, nurses, biomedical technologists², and others) mainly from eight institutions (medical education institutions and the biggest hospitals in Lithuania) were surveyed using a semistructured questionnaire. The second and third study stages (expert interviews and focus group discussions – see Table 1) were based on qualitative methodology and used nonstructured questionnaires for expert interviews and thematic guidelines for focus group discussions. The subjects of these two stages were experts, both medical professionals and physicists, all with scientific degrees.

To evaluate the attitudes of medical professionals toward the need for biomedical physics in medical studies and practice, the authors created a semistruc-

Table 1. Study stages and main goals

Research method	Sample size	Main goals
1. Survey of medical professionals	N=309	Reveal the needs of different level medical professionals for physics knowledge and practical skills Determine the most acceptable forms of education in biomedical physics
2. Expert survey of high-level medical professionals and physicists	N=18 (14 – biomedicine; 4 – physics)	Reveal the experts' perception of the place of physics in medical studies and the need for physics knowledge in medical practice
3. Focus group discussions with high-level medical professionals and physicists	3 focus groups	Identify the areas in biomedical physics with the greatest need for educational materials and courses, and highlight the specific characteristics of physics in medical study programs and continuing medical education Reveal the possibilities of cooperation among physicists and medical professionals in the field of medical studies at all levels

¹Holders of scientific degrees means those with a PhD.

²Prior to 2001, "biomedical diagnostic technologists" were called "laboratory assistants." In our study, the short term "biomedical technologist" includes medical professionals with one or the other of these titles.

tured questionnaire. Some questions were adapted from the questionnaires used by physicists to survey students' attitudes toward science and physics (25, 29, 30); other questions were formulated specifically to address the research objectives of this study.

This paper presents the study results based on the following thematic lines:

- The need for knowledge in biomedical physics:
 - (1) the perceived importance of physics knowledge – 5 statements;
 - (2) the need for physics knowledge in professional activities;
 - (3) the sufficiency or otherwise of the present physics knowledge in understanding medical technologies that are used in practice;
 - (4) the sufficiency or otherwise of the present physics knowledge in understanding new medical technologies.
- Possibilities for continuing medical education:
 - (1) Conditions, possibilities and shortages of continuing education for medical personnel;
 - (2) Acceptable forms of competency and knowledge improvement in biomedical physics for medical personnel.

Most of the questions use the five-point Likert scale, measuring the level of agreement/disagreement with statements.

Descriptive statistics were used to analyze the survey data from structured questions; nonparametric Mann-Whitney-Wilcoxon and Kruskal Wallis tests

were used for two and three independent samples, respectively, ($P < 0.05$) to calculate statistical differences among different groups of respondents. The data were processed using SPSS 15.0 software. Qualitative content analysis was used for open-type questions and for the data from expert interviews and focus group discussions.

Results

This study was targeted at revealing the needs and perceptions of medical professionals at different levels as regards physics knowledge in their professional activities. Such an approach encourages physics and medical educators to cooperate in developing medical curriculum at all levels. Their cooperation ensures that the needs of those medical professionals who use both theoretical physics knowledge and practical skills requiring knowledge of physics are best met. The study results are arranged according to the thematic lines and specific sampling characteristics presented in the “Methods” section of this paper.

1. The need for biomedical physics theoretical and practical skills. In order to reveal how respondents themselves perceive the importance of physics knowledge in their professional activities, five statements were formulated, and respondents were asked to identify the level of their agreement or disagreement with each statement.

Table 2 presents the mean scores and standard deviation for each statement in the total sample of 309

Table 2. Mean scores for the “perceived knowledge of physics” statements

Statement	Total sample N=309		Respondents with scientific degree N=67		Respondents without scientific degree N=242	
	Mean	SD	Mean	SD	Mean	SD
1. Knowledge of physics can help to understand physical processes in the human organism	3.90	0.73	4.08	0.66	3.85	0.75
2. Knowledge of physics allows me to better understand the treatment and diagnostic methods used at work	3.83	1.02	4.15	0.78	3.73	1.06
3. Knowledge of physics allows me to better master device used at work	3.72	1.05	3.90	0.91	3.68	1.09
4. I would like to know more about the application of physics knowledge in my specialization	3.46	0.96	3.68	0.88	3.40	0.98
5. Knowledge of physics is important in my specialization	3.44	0.90	3.66	0.81	3.37	0.91

The five-point Likert scale was used, where 1 corresponds to “strongly disagree,” and 5 corresponds to “strongly agree.” The Cronbach alpha reliability coefficient for these 5 statements is 0.865, identifying high internal consistency.

respondents and in subsets of respondents holding and not holding a scientific degree. As the results show, respondents perceive physics knowledge as being needed both in their specializations and in their practical activities. However, the tendency is to give greater emphasis to the practical applicability of physics knowledge (the mean scores of statements 2 and 3 about the practical applicability of physics knowledge are higher than those of statements 4 and 5 regarding the use of theoretical knowledge in specializations).

Respondents having a scientific degree consistently return higher mean scores for all questions than do those without a degree, but there was no significant difference between the results. A statistically significant difference of mean scores ($P=0.004$) was detected only for the responses concerning the use of physics knowledge in understanding the treatment and diagnostic methods used at work (statement 2).

The qualitative survey of experts and the focus group discussions also addressed the question of what are the needs for, and the role of, physics knowledge in medical education. The experts confirmed the respondents' opinion that there is a real demand for physics knowledge in medicine and identified the principal challenges in this field. The main problem identified is that medical students acquire too little knowledge of physics, especially related to their future specializations and practical work. Moreover, as specialized courses are not offered in residency and doctoral studies, there is a need for the development of elective courses in biomedical physics at the higher studies level. It was also perceived that biomedical physics upgrading courses were fragmented and given by medical practitioners, not by physicists. This again has an influence on the quality of patient treatment and safety.

As the survey target group was composed of various healthcare professions (from nurses to highly

qualified doctors), it is important to identify the main gaps in their physics knowledge as applied in their daily activities and in the use of medical devices and diagnostic methods. Such an analysis facilitates the preparation of teaching and learning materials targeting specific specializations not only for medical students, but also for continuing medical education.

Table 3 sets out the answers to the question whether respondents needed biomedical physics knowledge in their professional activities. The comparison was also made between those having and not having a scientific degree and between various health care professions.

As it can be seen from Table 3, those medical professionals who had scientific degrees expressed a greater need for physics knowledge in their professional activities than did those without a scientific degree, and this result was statistically different ($P=0.000$). These data also indicate that doctors give much greater importance to biomedical physics than either nurses or biomedical technologists, and that nearly 30% of biomedical technologists who are constantly dealing with physics-based devices have an unexpectedly low appreciation of biomedical physics.

Results from the Kruskal-Wallis test showed a statistically significant difference comparing various healthcare professions. However, when the groups were compared by pairs (Mann-Whitney test), there was a statistically significant difference between doctors and nurses ($P=0.000$), doctors and biomedical technologists ($P=0.000$), but only a very small difference between nurses and biomedical technologists ($P=0.032$).

In the survey, those respondents who answered "yes" or "partly" to the above question were asked why they needed physics knowledge. The results of this question are presented in Table 4.

The most important factor identifying the need for physics knowledge is therefore the professional

Table 3. Perceived need for biomedical physics knowledge in professional activities

Q: "Do you need biomedical physics knowledge in your professional activity?"	Total sample N=309, %	Respondents with scientific degree N=67, %	Respondents without scientific degree N=228*, %	Professional qualification		
				Biomedical technologists N=35, %	Nurses N=79 %	Doctors, N=122 %
Yes	36.2	56.7	30.3	5.9	20.9	47.8
Partly	55.3	40.3	59.6	67.6	71.6	49.3
No	8.5	3.0	10.1	26.5	7.5	2.9

*Only 228 out of 242 respondents answered this question.

Table 4. The reasons for using physics knowledge in professional activity

Q: "Why do you need biomedical physics knowledge in your professional activity?"*	Total %**	Biomedical technologists	Nurses	Doctors
1. Physics knowledge enables me to diagnose and treat patients better	56.3	24.3	44.3	74.7
2. Using physics knowledge and physics-based device saves me time	40.8	37.1	41.4	45.0
3. Applying physics knowledge makes me more competitive	34.0	40.0	28.6	44.4
4. Mastery of the methods and device related to physics knowledge gains me the respect of colleagues and students	25.6	22.9	18.4	31.3
5. Mastery of the methods and device related to physics knowledge, increases my earnings	10.4	26.2	2.9	17.5

*Answered by those respondents, who answered "yes" or "partly" to the question "Do you need biomedical physics knowledge in your professional activity?"

**Respondents could choose up to three answers, therefore the sum is higher than 100%.

aspirations of the respondents (the need to diagnose and treat patients better; statement 1), and the least important is the aspiration to earn more (statement 5). As in the previous question, the responses of the biomedical technologists were different from those of doctors and nurses. In this case, the different functions of biomedical technologists are clearly an important factor, and it may be that they lack a clear understanding of how important the quality of their work is for better diagnostics, treatment, and safety of patients.

Further analysis showed, as in previous cases, that those with higher scientific degrees consistently gave above-average responses (from 1 to 10% higher). A similar comparison was discussed above, in relation to physics knowledge in general and in professional activities. The results demonstrated that those medical professionals who had scientific degrees gave greater importance to the necessity for physics knowledge in all cases.

During focus group discussions, most medical (and physics) experts considered that the majority of medical professionals (doctors, nurses, biomedical technologists, physiotherapists) needed to understand the laws and principles of physics applying to medical devices in order to increase their ability to take responsibility for better diagnosis, treatment, and safety of patients. To this end, continual improvement of professional competencies in the biomedical physics field is essential.

Fig. 1 presents respondents' attitudes toward their sufficiency of physics knowledge for using and understanding medical devices.

The results in Fig. 1 indicate that only a small

proportion of respondents perceived their present knowledge of physics as sufficient for both understanding the functioning of the medical devices they used in practice and introducing new medical devices. The majority of respondents considered they had only a partly sufficient knowledge of physics for these purposes. In addition, it is significant that respondents evaluated more negatively their capacity to adopt new medical technologies than to understand the device in service. The supposition here is that their understanding of the functioning of medical devices is rather superficial: medical professionals possess the knowledge of how to use the devices without a deeper understanding of the physics principles underlying their functioning.

The results (Fig. 1) showed that one-third of respondents considered they lack the physics knowledge necessary to adopt new medical devices. This response, together with the thematic responses, indicates a need for new continuing medical education courses in the biomedical field and the preparation of teaching and learning materials targeted to the needs of medical professionals.

The qualitative survey of experts revealed a fragmentation of the learning process at all levels (undergraduate, graduate, PhD, residents) as regards physics knowledge, especially related to the use of medical devices. Experts identified several ways in which medical professionals acquire knowledge of the functioning of devices: (1) from colleagues; (2) during training organized by device distributors, and (3) from instruction manuals. This situation clearly identifies the need for specific specialized courses in biomedical physics given by physicists. These courses would

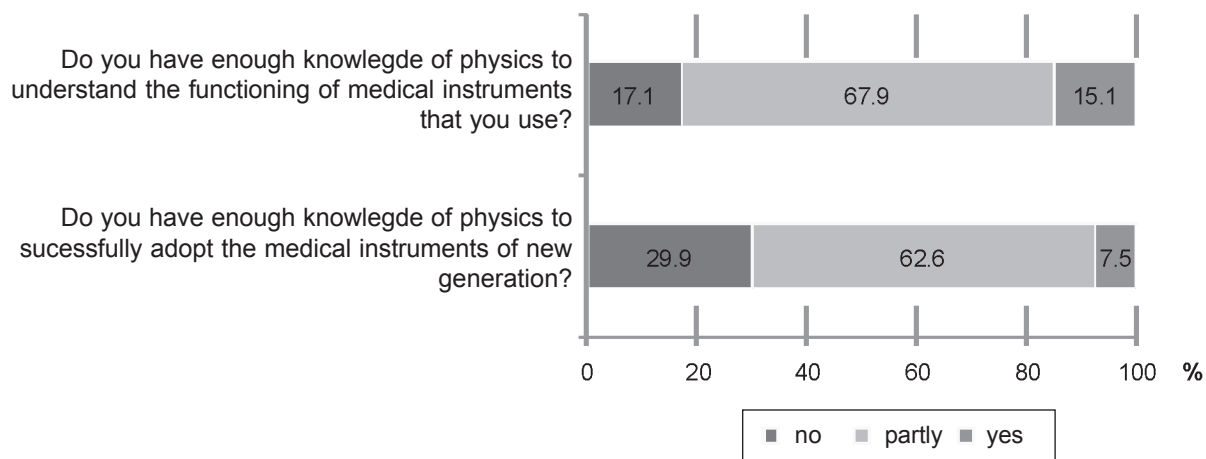


Fig. 1. The sufficiency of physics knowledge for understanding the functioning of current and new medical device (N=309)

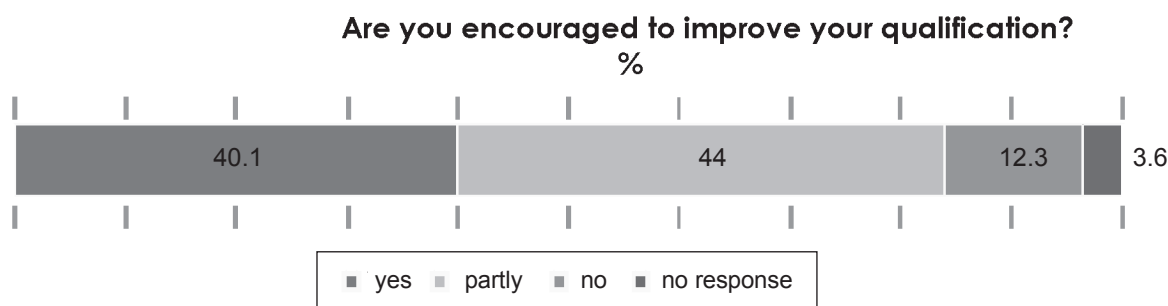


Fig. 2. The encouragement to improve qualification (N=309)

provide medical professionals with a more holistic understanding of the principles underlying medical devices, especially those of the new generation, and enable them to use the devices more effectively and safely.

2. Possibilities for continuing medical education. After having discussed the needs of various medical professionals for theoretical and practical biomedical physics, it is important to consider what are the possibilities for, and obstacles to, competency improvement at medical institutions. Respondents were asked whether they were encouraged to improve their competencies. The answers are presented in Fig. 2.

It should be noted that the percentage of those identifying that they were encouraged to improve their competencies was higher than the percentage of those who stated that they had very good conditions at work for continuing medical education. This finding may indicate that the wishes of employers to create possibilities for employees to improve their competencies do not always correspond with the real possibilities of the institutions.

Respondents were also asked to identify the main factors that encouraged them to improve their competencies and the main obstacles to such improvement³. The main factors, encouraging medical professionals to raise their competencies, were as follows: (1) personal aspiration for improvement (88.7%), (2) responsibility for patients (44.3%), and (3) legal requirements for licenses (32.7%). Two main obstacles were identified: (1) high workload, shortage of time (65.4%), and (2) financial problems, no possibility to pay for continuing medical education courses (45.3%). In addition, one-fourth of the respondents identified the lack of language skills as an obstacle to competency improvement. This response underlines the need for learning materials in Lithuanian.

In order to prepare up-to-date teaching and learning materials for the training of medical professionals in physics, it is important to consider what learning methods are most suitable for various target groups. Respondents were asked what were the most acceptable teaching and learning methods for physics. Table 5 presents the percentage of respondents identifying

³Respondents could choose up to three answers.

Table 5. Percentage of respondents indicating a method of learning is “mostly acceptable” or “acceptable” (N=309)

Methods	Respondents, %	Methods	Respondents, %
Practical work	78.9	Short-term courses	63.7
Books, textbooks	74.1	Scientific articles	50.5
Lecture	69.6	Long-term courses	44.0
Seminar	67.0	Distance learning	41.4
Specialized conferences	66.6	Project work	27.8

“mostly acceptable” or “acceptable” in response to this question.

Results indicated that respondents mostly required education through practical work and textbooks, and least acceptable was project work. It can be seen that methods requiring longer-term commitment were also less popular. We also asked an open question as to the form in which respondents would prefer materials for improving their qualifications in the biomedical physics field. Results show that nurses and biomedical technologists more often desired traditional textbooks while doctors, PhD students, and residents tended to prefer electronic and interactive means of learning.

During focus group discussions and expert interviews, the issue of biomedical physics courses for medical professionals was discussed. The main tendencies identified were as follows:

- Continuing medical education courses should adopt different teaching and learning methods for various healthcare professions.
- Distance learning opportunities should be included in the design of courses for medical professionals and instructors; the courses should be short, of narrow specialization, and clearly relevant.
- As only a small proportion of continuing medical education courses are funded, additional courses in physics training should be free and accredited.
- Courses should place greater emphasis on the needs of residents.
- Cooperation between medical specialists and physicists should be substantially developed in the preparation of teaching and learning materials for medical studies and continuing medical education courses.
- In Lithuania, there is a lack of medical physicists in health care institutions.

Discussion

Many studies (17, 18–22, 31) have demonstrated the increasing importance of physics knowledge for medical professionals. Directive 2005/36/EC on the

recognition of professional qualifications partially responds to this by specifically making physics input mandatory for the dental, pharmacy, nursing, and midwifery professions (32), but on the other hand, making no specification for medicine. This lack of specifications is also reflected in our study: in Lithuania such physics courses as exist in the medical curricula are taken at the basic medicine level, and no courses related to biomedical physics exist at the residency and doctoral studies level.

As a result, it can be stated that medical graduates starting their careers, as well as practicing medical professionals, frequently do not have the necessary physics knowledge at their fingertips, especially graduates from Vilnius University where the time allotted to physics is particularly short. The situation is exacerbated by the fact that continuing medical education courses contain only fragmented and limited biomedical physics content. This means that residency and doctoral students and medical professionals have no possibility of continually upgrading their knowledge of physics, and in our opinion, cannot truly master medical devices and methods, especially those at the cutting edge, with a consequent deterioration in the quality of patient treatment and safety. Compared with the state of medical education in other countries (24), continuing medical education in Lithuania does not benefit from a wide range of courses addressing the needs of high-level students and medical professionals for biomedical physics content. It is encouraging that several European associations have recommended the inclusion of physics in the medical curriculum for various health care professions, and this should be understood in the context of the EC directive concerning the recognition of professional qualifications and the facilitation of worker and researcher mobility through the creation of a European Higher Education Area.

The perception of medical professionals and high-level students as to the importance of physics in medicine as a whole, and in their professional activities

in particular, was shown in our study to be *mostly positive and considerably above average* (from 3.37 to 4.15 on a five-point scale). Respondents identified that *knowledge of physics was needed* both in their particular specialized field of medicine and in their practical work. The *practical skills* required to master new medical devices were *identified as more important than theoretical knowledge*. Similar findings were identified in a slightly different context, by the 1989 study of the Committee on Training of Radiologists of the American Association of Physicists in Medicine (cit. in 16).

The most *important factor* determining the need for physics knowledge is *professional aspirations* (the need to diagnose and treat patients better), less so in the case of biomedical technologists. Respondents indicated that physics knowledge in their practice was little related to the possibility of increasing their earnings.

The need for physics knowledge, in practice as well as in specialized fields, is valued more highly by respondents with scientific degrees and by doctors rather than by nurses and biomedical technologists. They particularly insist on the role of physics knowledge with regard to treatment and diagnostic methods. It can be assumed that studying for a scientific degree gave these respondents a deeper understanding of the importance of scientific knowledge for professional development and practice. This observation can be compared with the findings of other publications (18, 22, 29), which affirmed the importance of science in medical studies.

Only a small proportion of respondents indicated that their knowledge of physics was sufficient to understand the working principles of their devices or to master the new generation of medical devices (the majority indicated that it was only partially sufficient). In the same way, the respondents judged less favorably their capacity to successfully master new medical devices than to understand existing devices.

It can be assumed that *understanding* how to use devices is more often *functional in nature*, knowing how to use devices without understanding their working physics principles. Also the fact that one-third of the respondents indicated they lacked the physics knowledge necessary for mastering new generation devices shows that there is a need to create qualification upgrading courses and teaching and learning materials purposively oriented toward the needs of medical professionals.

Qualitative analysis of the answers from medical and physics experts revealed that such biomedical physics courses and materials should also address the

two levels of medical studies: firstly, a basic general level of physics knowledge, and secondly, a level oriented toward specialized fields of medical studies and medical practical work. At this second level, we recommend the inclusion of interdisciplinary courses taught jointly by physicists and by medical professionals. In addition, the previously identified lack of medical physicists in Lithuania also requires corrective action through intensified training programs.

It is clear from our findings that medical professionals are motivated to improve their competences and qualifications, the most important factors being personal motivation, responsibility for patients, legal requirements for licenses, and the opinion of colleagues. However, the concrete possibilities that medical professionals may have to improve their competences must be taken into account when preparing courses for continuing medical education. Our survey revealed that the main obstacles for continuing medical education faced by medical professionals were their heavy workload and their financial possibilities to pay for the courses. Indeed, one in four respondents stated that the lack of favorable conditions in their institutions for improving their qualifications was a major obstacle. These findings highlight a real problem that affects the possibility of offering effective continuing education to medical professionals. It is therefore important that ways be found to offer free courses in distance-learning format to meet the needs of medical professionals.

The respondents' answers indicated that there is a need to combine traditional methods with distance education techniques based on modular structures. Indeed, our findings confirm those of other studies (7) that many physicians prefer traditional, passive methods of instruction, but also show that more than 40% like distance courses, a result comparable to the findings of other studies (27). The most appropriate *physics teaching and learning methods* for professionals were identified: nurses and biomedical technologists desired traditional textbooks, whereas doctors, PhD students, and residents more often preferred electronic and interactive means of learning. In all cases, teaching and learning methods that require a longer-term commitment were identified among the least popular methods, and methods based on practical work were clearly the most popular. In response to this, teaching and learning materials developed during the project were prepared in traditional formats, but also in an electronic format with a view to the future, and to facilitate updating.

Cooperation between medical specialists and physicists is an important issue regarding the preparation

of high-quality teaching and learning material both for medical students and medical professionals. Both medical and physics experts noted that although cooperation is common in the area of scientific research, there is a substantial lack of cooperation in the preparation of teaching and learning materials for medical studies and continuing medical education. This point confirms the assertion of Caruana et al. (16).

In the future, we intend to develop further the findings of this study and explore the directions identified in a more comprehensive research project using a far wider sample of various health care professions from Lithuania and other European countries.

Conclusions

The study presented in this paper was targeted at revealing the needs of medical professionals for knowledge of biomedical physics both at theoretical and practical levels. The study concludes that with respect to the learning needs of medical professionals:

- *Knowledge of physics is needed* both in their particular specialized field of medicine and in their practical work;
- Medical professionals with scientific degrees perceive the need for knowledge of biomedical physics in their professional activities as being more important than do those without scientific degrees;
- The most important factor determining the need for physics knowledge is professional aspirations

(the need to diagnose and treat patients better);

- Present continuing medical education courses contain only fragmented and limited biomedical physics content;
 - The development of new biomedical physics continuing education courses for medical professionals should be conducted in close cooperation between professionals in physics and medicine.
- And also as regards the possibilities and obstacles in participating in continuing professional development in biomedical physics:
- Personal motivation, responsibility for patients, legal requirements for licenses and the opinion of colleagues are the most important motives for upgrading competences;
 - Workload and financial stringency are the main obstacles to upgrading competences;
 - Teaching and learning methods based on practical work were clearly the most popular, and those requiring a longer-term commitment were the least popular.

Acknowledgments

The authors wish to thank the medical professionals who participated in this study and colleagues from partner institutions who helped to organize the gathering of data. In addition, we thank the European Union Structural funds (Project No. ESF/2004/2.5.0-03-385/BPD-210) for its financial support of this study.

Biomedicinos fizika tęstinėse medicinos studijose: mokymosi poreikių analizė

Ričardas Rotomskis, Violeta Karenauskaitė¹, Aistė Balžekienė²

Vilniaus universiteto Onkologijos institutas, ¹Fizikos fakultetas,

²Kauno technologijos universiteto Socialinių mokslų fakultetas

Raktažodžiai: biomedicinos fizika, tęstinės medicinos studijos, medicinos profesionalai, kvalifikacijos kėlimas.

Santrauka. *Tyrimo tikslas.* Atskleisti medicinos profesionalų Lietuvoje poreikius biomedicinos fizikos tęstiniam mokymuisi bei praktinėms žinioms.

Tyrimo medžiaga ir metodai. Tyrimas paremtas 309 medicinos profesionalų apklausa, trijų fokusuotų grupių diskusijomis ir 18 interviu su medicinos ir fizikos ekspertais.

Rezultatai. Tyrimas parodė, kad medicinos profesionalams trūksta biofizikos žinių: tik 15 proc. respondentų nurodė, kad jiems pakanka fizikos žinių suprasti naudojamų prietaisų veikimą, tik 7 proc. respondentų mano, kad jiems pakanka žinių naujos kartos medicinos prietaisams įsisavinti. Fizikos žinių poreikis labiau vertinamas respondentų, turinčių mokslinius laipsnius. Ištyrus kvalifikacijos kėlimo motyvą ir kliūtis, paaiškėjo, kad pagrindiniai kvalifikacijos kėlimo motyvai yra asmeninis siekis tobulėti (88,7 proc.) bei atsakomybė pacientams (44,3 proc.), tuo tarpu pagrindinės kliūtys yra didelis darbo krūvis (65,4 proc.) bei ribotos finansinės galimybės (45,3 proc.). Priimtinausiu tęstinio mokymosi metodu respondentai įvardijo praktinį darbą (78,9 proc.) ir metodus, kuriems įsisavinti nereikia daug laiko, o mažiausiai priimtinu mokymosi metodu įvardytas projektinis darbas (27,8 proc.).

Išvados. Tyrimas parodė, kad biomedicinos fizikos žinios yra reikalingos įvairiose medicinos specializacijose bei praktiniame medikų darbe, o pagrindinis motyvas kelti kvalifikaciją yra profesinis tobulėjimas. Medikų biofizikos žinios, naudojant medicininę įrangą, yra daugiau instrumentinės. Profesinės kvalifikacijos kėlimo kursuose biofizikos žinios pateikiamos labai fragmentiškai, todėl, bendradarbiaujant fizikos ir medicinos ekspertams, turi būti kuriami nauji tęstinio mokymo kursai, atitinkantys specializuotus medicinos personalo poreikius.

Adresas susirašinėti: V. Karenauskaitė, VU Fizikos fakultetas, Saulėtekio al. 9, 3 korp., 10222 Vilnius
El. paštas: violeta.karenauskaite@ff.vu.lt

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Received 17 November 2008, accepted 6 November 2009
Straipsnis gautas 2008 11 17, priimtas 2009 11 06