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EDUCATIONAL NEEDS OF LAPAROSCOPIC SURGEONS

Joanna Bartnicka
Agnieszka Ziętkiewicz
Faculty of Organization and Management
Institute of Production Engineering
41-800 Zabrze, ul. Roosevelta 26-28
e-mail: Joanna.Bartnicka@polsl.pl;
e-mail: Agnieszka.Zietkiewicz@polsl.pl
Grzegorz Kowalski
District Railway Hospital in Katowice – S.P.Z.O.Z.
Department of General Surgery
40-760 Katowice, ul. Panewnicka 65
e-mail: kowalskig_xl@wp.pl

Abstract: The development of methods and techniques of medical laparoscopic procedures, including among others, a high degree of surgical instruments complexity, forces the need of improving the professional skills by surgeons.
Within the article's introduction the educational needs in the field of laparoscopic surgery identified on the basis of the analysis of data obtained from the survey of laparoscopic surgeons are described.
In addition the authors recognize the state of education in Poland in range of laparoscopic surgery and develop a recommendation for supporting learning process as well as improving vocational skills.
The process map of learning path of laparoscopic surgeons is developed in frame of general surgery specialization as well as the teaching methods are reviewed for all of the possible educational levels in Poland. The current state of the way of teaching process including certain methods and forms of trainings is presented on the basis of competency matrix.

Keywords: organization of education, surgery, laparoscopy, vocational training, practical skills, teaching methods, IT trainings

Introduction

Laparoscopic surgery belongs to the young, but rapidly developing domains of minimally invasive surgery and nowadays is used in all areas of general surgery [15].
The inclusion of laparoscopy to the accepted by surgeons treatment procedures took place at the turn of 1989 and 1990 changing the face of surgery, mainly in Western Europe and the United States of America [13]. The numerous scientific studies confirmed that laparoscopy is safer in the comparison of open surgery, and its use is associated with less postoperative pain, shorter hospital stay and shorter inability to work [7]. The noted positive results of minimally invasive treatments caused the systematically crowding out the traditional and invasive surgical techniques and now, also in Poland, the laparoscopy is a standard technique in numerous surgical procedures. The most common laparoscopic procedures in Poland are gallbladder removal, appendectomy, splenectomy, fundoplication surgeries, abdominal hernia surgeries, colon resection, bariatric surgeries.
The observed continuous development of laparoscopy has implied the improvement and development of surgical techniques as well as the equipment and surgical instruments associated with them. The new ways of operating based on videosurgery technology replaced the existing standards of medical practice forcing at the same time the new action for education and training surgeons. At the same time new ways of operating technology-

based videosurgery, replaced the existing standards of medical practice forcing at the same time the actions for education and vocational training for surgeons.

The history of teaching laparoscopic techniques began in the moment of carrying out the first transmitted cholecystectomy via television station in the United States in 1989. The new technique gained then many supporters who wanted to learn how to operate with using the new laparoscopic technique. The first systematic courses in the field of laparoscopy were organized as weekend meetings, and the waiting time for the course attained several months. The drawback of the contemporary courses was the lack of teaching standards and exercise equipment [13]. The based on the schema master - student trainings were also inadequate. The new technologies, tools and operating methods which were entering the operating room caused the fact that both the master and the student turned out to be equal to each other novices, which was not acceptable to the master and often created a mental barrier in the development of laparoscopic surgery [5, 18].

Thus, together with the development of laparoscopy the training process in the field of surgery had to be transformed. Individual countries, including Poland, formulated their own more or less effective education systems for surgeons (see p. Organization of surgeons education in Poland).

However, the currently selected training centers located in Europe: France, Germany, Belgium, Netherlands have the crucial significance. For this reason, many Polish surgeons deepen their knowledge of the latest laparoscopic techniques mainly in foreign centers.

It should be remembered that, apart from the well-trained medical staff, the use of specialized equipment and tools adapted to this type of operation is required.

All these aspects make the necessity of an active clinical surgeon possessing current knowledge not only in clinical medicine, but also improving the technical skills associated with the maintenance and operation of equipment, including the selection and preparation of equipment in terms of comfort and ergonomics, as well as possessing skills to cope with stress and interpersonal skills relating to activities in the complex surgical team.

The multithreading knowledge and skills in the field of laparoscopy makes the learning curve elongated, and the improvement of surgical techniques is an action that is burdened by many organizational, technical and financial barriers.

It is important, therefore, to take the actions for improving the learning process in the field of laparoscopy in such a direction that the knowledge on the newest techniques is widely available to surgeons and present in a form that will allow them to gain practical skills.

The objective and methodology

Taking into account the above considerations a work objective was formulated as the identification of the educational needs and furthermore the development of recommendations in range of supporting learning process and improving professional skills in the field of laparoscopic surgery. The scope of the research included analysis of three possible paths of education provided by Polish law in the field of general surgery, i.e.:

– six-year higher education,
– postgraduate education: postgraduate traineeship, specialized courses, vocational training courses,
– self-study.

Each educational path has been treated as a case study, the analysis of which included the following aspects:

– the formal and legal basis,
– the dominant organizational forms and methods of education,
– the achieved powers, qualifications,
– the gaps and educational barriers.

There were used different methods of collecting data and information:

– analysis of legislation in the field of medical education existing in Poland,
– analysis of Polish and world literature in the field of education in laparoscopic surgery, including modern methods of teaching,
– a preliminary survey defining the state of the surgeons knowledge about laparoscopic procedures,
– the free interviews with two surgeons on the state of the teaching laparoscopic surgery in Poland,
– analysis of the curriculum at different stages of education.

In turn the main analytical methods were:

– data analysis based on descriptive statistics,
– process mapping,

– competence matrix.
The conclusions were formulated for the diagnosis of training in laparoscopic surgery in Poland on the basis of performed studies, giving the ground to the development of guidelines for the organization of vocational training based on modern and effective forms and methods of teaching.

Recognition of the learning condition and learning needs in the field of laparoscopic surgery in Poland
The survey results

The objective of the survey was to diagnose the state of knowledge within laparoscopic surgeons in Poland. The results of the survey allow to determine the basic needs in terms of how to educate in effective way in the field of laparoscopic surgery.
The questionnaire was created as a part of the international project titled „Online Vocational Training course on laparoscopy's ergonomics for surgeons and laparoscopic instruments' designers", Program Lifelong Learning, Leonardo da Vinci Multilaternal Projects for Development of Innovation, number 527985-LLP-1-2012-1-ES-LEONARDO-LMPLapForm. The selected results referring directly to the formulated study objective is presented in this article.
The survey was conducted in six hospitals in the province of Silesia on the population of 56 surgeons performing laparoscopic procedures.
The average length of work of the respondents was 12.3 years, which means that the answers are crucial meaning for achieving the study objective due to the many years of experience in performing laparoscopic procedures. The vast majority of laparoscopic surgeons are men who represent 75 per cent of respondents (Figure 1). A clear majority of people are over 36 years old. Surgeons aged 25-35 are less than 30 percent of respondents (Figure 2).
The age of respondents is related in a certain extent to the post held. Figure 3 shows the structure of employment according to the post held by respondents.

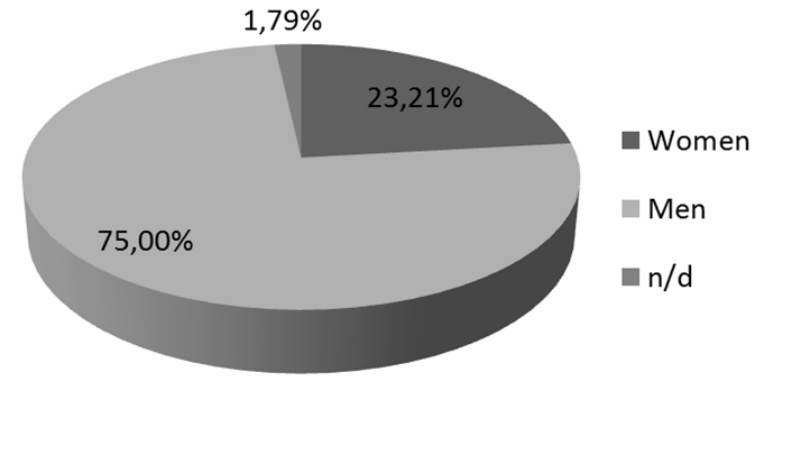

Fig. 1. The structure of respondents by gender

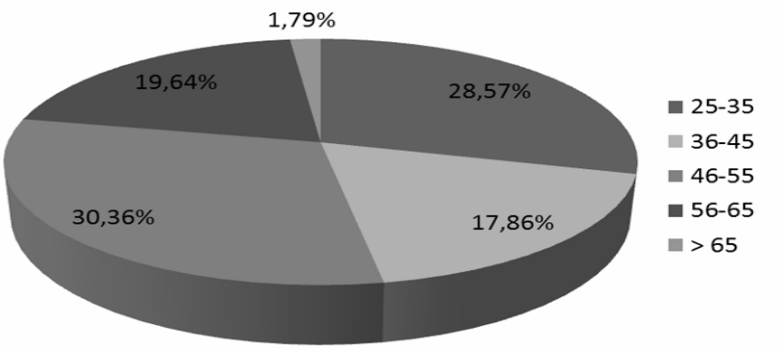

Fig. 2. The structure of respondents by age

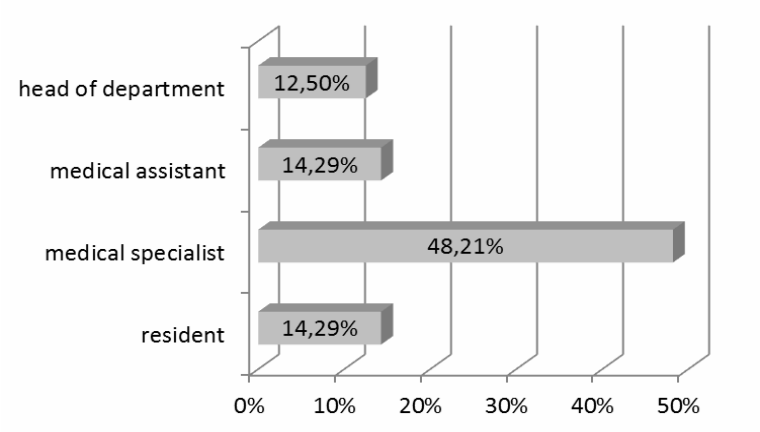

Fig. 3. The structure of employment

A relatively small number of young doctors, especially residents (people who actually are specializing in a particular field of medicine) may be caused by the fact that a specialization in the field of general surgery is considered as a specialization with a high degree of difficulty. General surgery among others laparoscopic surgery requires from the surgeon an extraordinary concentration during the entire procedure and a necessity of making unforeseeable decisions. As opposed to, for example, orthopedic surgery, where surgeries are performed in a schematic manner and the result of the treatment depends on the mechanical accuracy of surgical operations, in general surgery it is not possible to act according to strict schematics.

Most surgeons spend from 1 to 2 hours per day for performing laparoscopic procedures (Figure 4).

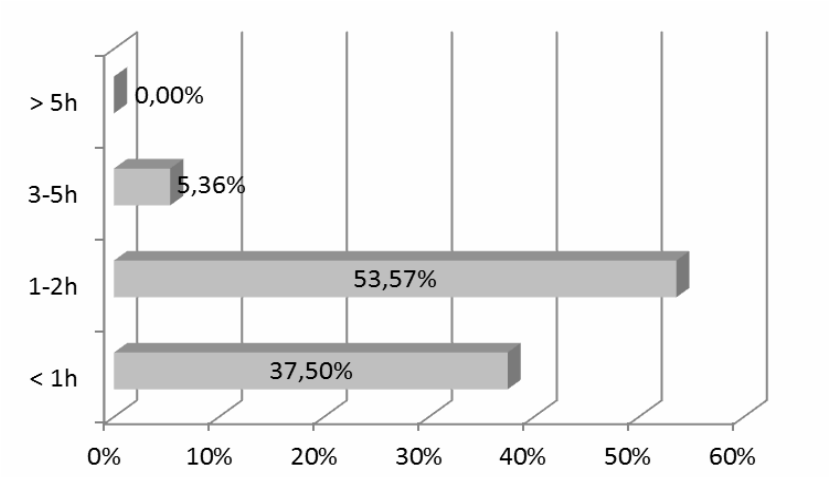

Fig. 4. The average length of operating by laparoscopic surgeons per day

The most frequently laparoscopic procedures performed by surveyed respondents are the surgeries inside the abdominal area, including the gallbladder removal, and inguinal hernia repair.

Laparoscopy is a rapidly expanding field of medicine, and the same execution of procedures requires reliable preparation. According to the respondents the most important factors influencing on improving skills in laparoscopic surgery are:

– performing as many procedures as possible,
– the opportunity to participate in trainings including practical trainings based on simulators,

– the possibility to access to laparoscopic instruments,
– performing staged operations,
– good quality of laparoscopic instruments.

The attention was paid also to such aspects of improving professional skills as the exchange of experience between coworkers and the support of more experienced surgeons.

More than 80% of respondents participated in trainings from laparoscopy. The majority of them (32 people), rated the trainings at a good level, only 6 people identified them as very good. However nearly 18% of respondents did not participate in any kind of laparoscopic training (see Figure 5).

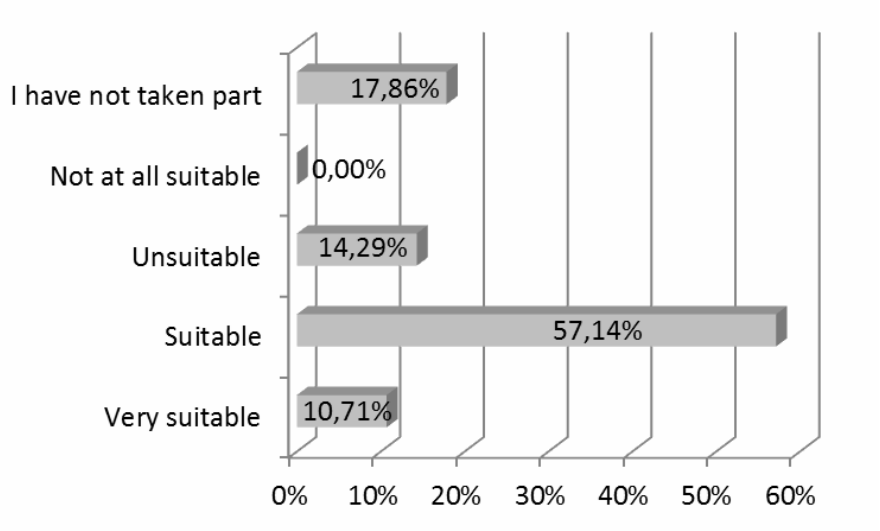

Fig. 5. The assessment of laparoscopic trainings

Summarizing the results of the survey, it can be concluded that in spite of the respondents' satisfaction of completed trainings, they highlighted the necessity to further improvement of skills based on practical exercises, and hence on perfecting the technique of surgery. Also the scientific literature pays special attention to improve technical competences of the surgical staff [17, 12, 10], and simultaneously indicates the deficiencies in this field [17].

The declared in the survey large number of people who participated in the trainings in the field of laparoscopy may be caused by the obligation of completing a specialized course of laparoscopy as a mandatory during specialization in general surgery and is stipulated by law [25].

It should be emphasized that the results of the survey, due to its preliminary purposes, will not indicate a clear opinion on the effectiveness of and evaluation trainings in the field of laparoscopic surgery. However, as it already was pointed out, the results have highlighted the need to include the interactive and practical trainings into educational path of laparoscopic surgeons.

Organization of surgeons education in Poland

The legal basis for surgeons education in Poland are following acts:

– Act on the professions of a physician and a dentist dated 5 December 1996 [22],
– Regulation of the Minister of Health dated 6 October 2004 on methods of fulfilling the professional training requirement for physicians and dentists [23],
– Regulation of the Minister of Health dated 24 March 2004 on the post-graduate traineeship of physicians and dentists [24],
– Regulation of the Minister of Health dated 24 March 2004 on the specialization of physicians and dentists [25],

The analysis of the above mentioned documents allowed to order the information and develop the process map of medical education of surgeons specializing in general surgery (Figure 6). This particular specialization takes into account the domain of laparoscopic surgery.

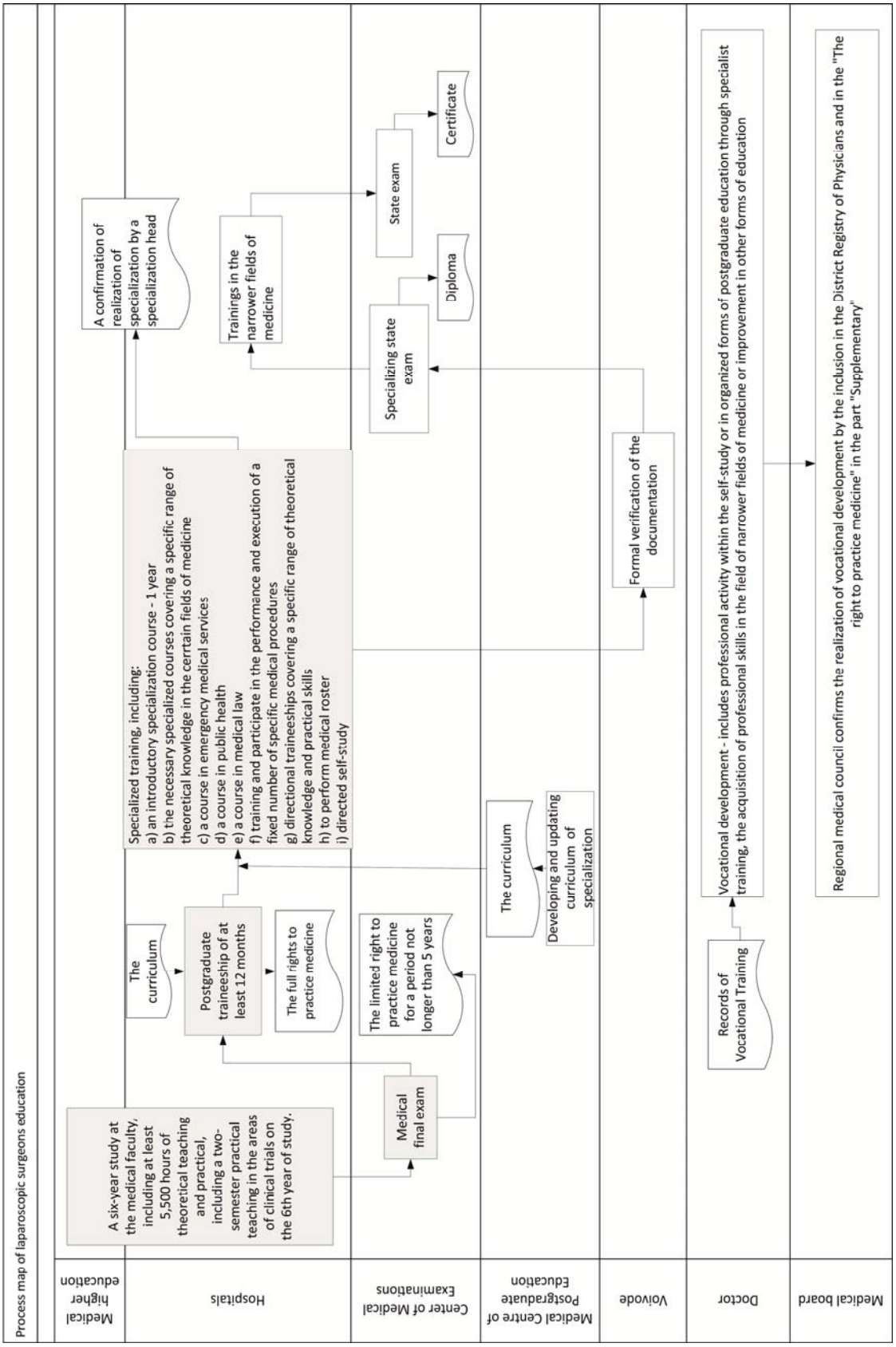

Fig. 6. Process map of laparoscopic surgeons education

The complexity of the structure of entities involved in the process, as well as the detailed guidelines for carrying out a specialized training are highlighted here.
The moment when the doctor can for the first time get familiar with the practical aspects of performing laparoscopic procedures is a two-semester practical teaching in the areas of clinical domains on the 6th year of study.
After finishing medical school and successful completion of the state final exam, a graduate receives a temporary and limited right to practice as a doctor. Another point on the path of medical education is a post-graduate traineeship lasting at least 12 months.
Within the traineeship it is possible to get acquainted with operating techniques by students. After completing the traineeship a graduate receives the full rights to practice medicine. This right does not allow, however, to perform specialized procedures such as laparoscopic surgical procedures.
Such a right is received only by those doctors, who have completed specialized training including, among others, specified range of theoretical knowledge in the field of medicine and practical knowledge acquired through participation in performing and performance of a predetermined number of specific surgery or medical procedures. Only at this stage of training the future surgeon has a direct opportunity to participate in the laparoscopic surgeries as an operator assistant, and thus to acquire practical skills in this field.
The completion of the specialization completed with the specializing state exam authorizes a doctor to perform laparoscopic procedures.
In addition to the described surgeon's education path, there is an obligation of a continuous document of a surgeon's vocational development. The quantitative measure of how to meet this obligation is to obtain during a given billing period, the certain number of the educational points.
The presented above process of education and training for medical surgeon is a formal path. Another aspect in improving the surgeon's skills by self-training or trainings that are not gratified by points (here we can speak about an informal learning path).
The self-improvement or consolidation of skills is usually based on the professional literature, mainly English-speaking, procedures catalogs, manuals of using medical tools and equipment (often with strong technical background), medical reports published on specialized web portals, or different types of trainings, e.g. organized by the hospitals in collaboration with manufacturers of medical equipment.

Educational methods for teaching laparoscopic surgery. Analysis of the current state in Poland

Taking into account the objective of the article, which is to identify the educational needs in range of laparoscopic surgery the analyzes of presented above training path in terms of teaching methods and forms two areas of learning content were performed. A matrix of training methods for surgeons on the basis of an interview with the laparoscopic surgeon was developed (Figure 7). The matrix illustrates the current state of learning process in Poland.
The principal method of teaching at universities is a lecture. This method seems to be appropriate, if there is a need to introduce students to particular topics, or to present more details of certain issues. However, the main disadvantage of the knowledge transfer through lectures is the lack of interaction between the lecturer and the audience, who are the passive recipients of knowledge. A lecturer usually does not asses the degree of the adjustment of learning content to absorption capacity of listeners, which may cause misunderstanding the topics that are undertaken within the framework of the lecture.
The complement of the lecture are exercises in which students actively participate and whose objective is to practically implement the knowledge derived from the lecture.
Considering the learning program within medical studies it can be concluded that knowledge of surgical procedures, including laparoscopic procedures, is transferred in a very limited way.
This is not a problem in the case of postgraduate traineeship and particularly in the case of specialized training. The dominant teaching methods here are practical exercises. The main emphasis is located in becoming familiar with medical practice of various specialties (postgraduate traineeship) and in shaping the practical skills of medical specialization (specialized training).

	6-year higher education	Traineeship	Specialization	Free trainings organized in collaboration with manufacturers	Payable trainings in Polish training centers	Payable trainings in foreign training centers	Conferences/ worksops/ seminars
Teaching methods							
Lecture	✳						✳
Exercises	✳	✳	✳				
Demonstration of operation - live		✳	✳	✳			
Transfer video on-line or off-line				✳			✳
Trainings on simulators - robots					✳	✳	
Trainings on animals					✳	✳	
Development of manual skills on trainers				✳	✳	✳	
Learning kontent							
Development of interpersonal skills	✳	✳	✳				
Ergonomics					✳	✳	

Fig. 7. The matrix of training methods for laparoscopic surgeons

In particular, the methods of acquiring knowledge by students are direct observations including live presentations of real surgeries. The last form of learning is also often used during free trainings conducted by hospitals in cooperation with the manufacturers of medical equipment and during scientific events like conferences, seminars or workshops.

A positive aspect of such a method of teaching is the transfer of practical knowledge (procedural knowledge [19]). On the other hand, the transferred knowledge refers usually to standard procedure rules during the certain cases of recorded surgical surgeries, while an important aspect of learning is to discuss many cases, indicating numerous options of non-standard procedures. In addition, the students usually are a group of passive observers, what makes it difficult to acquire by them skills of how to operate, e.g. operate the laparoscopic instruments, what is one of the key element of the laparoscopic technique.

Actually these skills are acquired during training on simulators - robots, exercises on animals or on trainers. At the same time, while the last indicated method is present during the free trainings, so all three methods are used mainly during payable trainings both domestic and foreign, and therefore potentially less available to young staff of doctors. The main reason for this is the high costs associated with the purchase and maintenance of the simulator and the organization of exercises involving animals.

Comparing the results obtained from the analysis of the matrix and of the survey (see point: The survey results), it can be concluded that there is a dissonance between the needs of surgeons in range of shaping operational skills, which are mainly based on the trainings with simulators or other trainings based on simulating the laparoscopic procedures and the offers of training for free. Additionally it should be emphasized that the free trainings are organized mainly in hospitals and access to them is limited.

Another important issue incorporated in the matrix is learning content in the range of development of interpersonal skills and ergonomics. These skills are not directly related to the area of medicine, but are very important part of the surgical team work. Interpersonal skills support the flow of information and workflow during laparoscopic surgery, and thus the reduction of the risk of errors during the procedure, and the knowledge of ergonomics allows doctors to intentionally create the work conditions in the operating room and thereby reduce the risk of static overloading, which is currently one of the most bothersome side effects of laparoscopic surgeons work [2, 6, 9]. The issues about interpersonal skills are taken during medical studies, postgraduate traineeship and specialist training, whereas ergonomic issues are not a subject of learning available to

a wide audience, because they are acquired (but not always) in payable trainings.

The modern ways of supporting learning process in the field of laparoscopic surgery

As mentioned before, the modern training methods indicated in the matrix are available during payable trainings and based inter alia on IT technologies. One of such IT technologies used in the trainings for surgeons is Virtual Reality (VR) or Virtual Environment (VE). The essence of these technologies is to provide the user with the artificial stimuli acting on the senses receptors and thus simulating the phenomena which could occur in the real world. For this technology different kinds of special input and output devices (computer, goggles, motion controllers, touch sensors, etc.) are used [14]. The main advantage of this technique is the ability of interaction between the trained and three-dimensional computer models, which can be deformed in real time and thus allow to learn the procedures and surgical treatment methods in a practical way. However, the main problem of the use of virtualization techniques is the difficulty of obtaining such computer models that do not only visually imitate human anatomy and physiological phenomena, but also reflect the physical phenomena, such as voltage, resistance and plasticity of tissues [10]. The trainings based on VR have not yet had a wide application and they are thematically narrowed to a small number of medical procedures mainly from the field of laparoscopic procedures. This is caused by, inter alia, high costs of production of simulators and development of the high quality interactive computer models. Figure 8 shows an example of the simulator based on VR technology and supported trainings in laparoscopy.

Fig. 8. The example of laparoscopic simulator [21]

Related to VR techniques for developing skills are techniques based on the Augmented Reality (AR). The essence of AR technology is to complement the surrounding world with the artificial elements. In general these are the elements in the form of virtual models, extras sound, flavorings and other impacts on the senses system and the human motor system. The improvement of the medical staff skills by using AR technology has previously found application in the field of minimally invasive surgery, where a number of the used cases are noted in laparoscopy. The advantage of trainings based on AR technology is the ability to use the real surgical instruments giving the illusion of reality of laparoscopic surgery, including the resistance and tactile sensations [3, 11] and also the ability to create many

variants of the training scenarios through unlimited visualization of anatomical images [8]. Figure 9 shows an example of the application of AR to improve surgical skills.

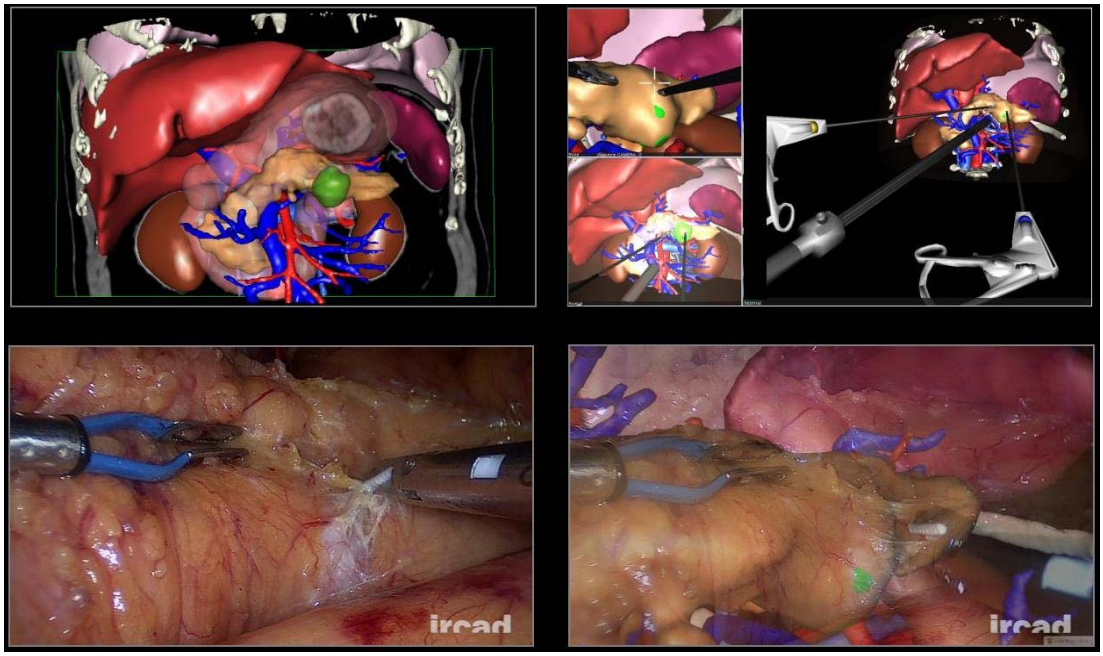

Fig. 9. The example of AR technology use to improve surgical skills [20]

The studies show the advantage of AR technology over VR, taking into account first of all the ability to create the conditions with the physical reality of the training station and the tactile interaction when performing surgical activities [3, 4]. The use of AR technology as a hybrid system gives the combination of features specific to the physical simulator: interactivity and realism and virtual simulator, i.e.: the objectivity of the assessment of surgical activities and individualized training [16].

Conclusion

Developing and improving the skills of laparoscopic surgeons can take place through various forms and methods of teaching. The identified needs in this area relate to the lack of wide access to practical trainings and exercises. These methods are in fact available to a limited group of customers due to the high cost of participation in such learning forms.

To summarize the current state of teaching method in the field of laparoscopic surgery it is proposed to complement the available methods of learning by the new one, that will allow increasing the trainees activity and verifying the knowledge and at the same time will be common for customers and cost-effective. The implementation of the proposals can be done by enriching the learning content for example through:

– The development of interactive handbooks which are integrated with "live examples" provided via Internet e.g. via online e-learning platform. The combination of learning content in traditional handbooks with such examples as videos or computer simulations is possible by using markers such as 2D (so-called photo codes) located inside a handbook. The concept of this solution is included in [1].
– Enriching the learning content at all levels of medical education with scenarios of possible cases that may happen during the course of certain surgical procedures. These scenarios are based on complex case studies and include rules of inference that are known from the traditional expert systems.

The above-mentioned proposals can be implemented within an e-learning platform, what guarantees relatively inexpensive and wide access to practical and interactive content shaping the skills at all levels of learning process of laparoscopic surgeons.

The fulfillment of the postulate of increasing the availability to practical training in the range of using instruments based on the staged activities may be done in turn by organizing internal-hospital workshops with the use of real surgical instruments and dummies containing in the middle of the selected animal organs, see Figure 10.

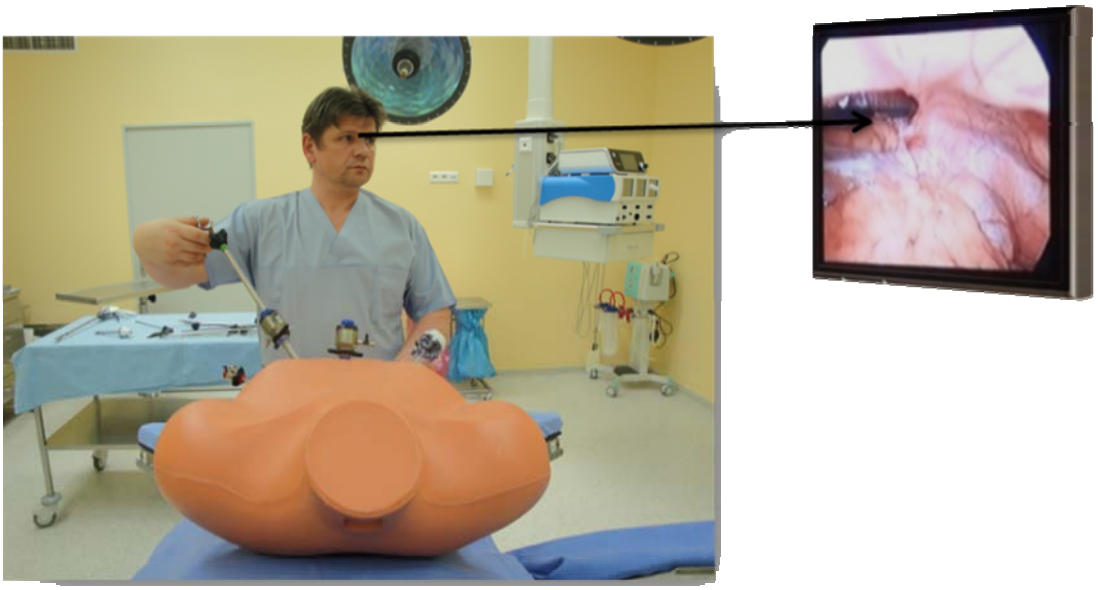

Fig. 10. The example of the staged activities with using dummies

The basis for staged trainings can be pre-registered laparoscopic procedures displayed on-line with the use of multimedia devices which are patterns to follow during performing certain types of activities by a trainee.

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