CRITICAL CARE INNOVATIONS JOURNAL

ORIGINAL ARTICLE

Critical Care Innovations
2018; 1(1):1–15

www.criticalcareinnovations.eu

Prospective evaluation of interactive project of Emergency Medicine Exam with the use of multimedia computer devices.

Arkadiusz Wejnarski [1, 3], Pamela Antonella Gajek Villebæk [2], Piotr Konrad Leszczyński [3] ORCID https://orcid.org/0000-0002-3408-3591 .

[1] *Helicopter Emergency Medical Service, Warsaw, Poland*
[2] *Halsnæs Kommune, Frederiksværk, Denmark*
[3] *Department of Nursing and Emergency Medicine ,Siedlce University of Natural Sciences and Humanities, Siedlce, Poland*

ADDRESS FOR CORRESPONDENCE:

Piotr Konrad Leszczyński, Department of Nursing and Emergency Medicine, Siedlce University of Natural Sciences, and Humanities,

Prusa 14, 08–110 Siedlce, Poland; e-mail: piotr.leszczynski@uph.edu.pl

INTRODUCTION: Digitisation and implementation of IT solutions is contemporarily an intrinsic element while carrying out emergency medical activities. However, the system of education and evaluation of paramedics is conducted in a traditional way in Poland. The aim of the paper was to implement and critically evaluate the project of Emergency Medicine Exam conducted with the use of multimedia computer devices.

MATERIAL AND METHODS: The undergraduates took part in a test consisting of fifteen questions concerning medical emergency activities conducted in a traditional (written) and interactive (computer) form. An original tool was developed and it enabled us to apply interactive tasks and centralize statistics. The achieved results underwent parametric tests (T-Student test, T – test for dependent samples with Pearson's Correlation Coefficient) at significance coefficient of $p<0,05$.

RESULTS: Average percentage results of both forms of the test including all the question categories indicated a statistically significant difference in the test with both samples for averages , where $p=0,001$ (59,09 % ± 12,16 vs 49,36 % ± 17,61). The number of people who did not succeed in passing the test at 51% passing point was 6 in the traditional test and 10 in the interactive one. Satisfaction analysis indicated the highest mark for detailed feedback (Me=5,95; from 1 to 6 scale).

CONCLUSIONS: Multimedia computer devices may be efficiently used while implementing Emergency Medicine Exam. The evaluation of non-technical skills, thanks to the introduction of interactive tasks, enables a more detailed assessment of the competence of candidates for paramedics.

KEY WORDS: Test, Multimedia, Interactive, Computer, Emergency Medicine

INTRODUCTION

IT solutions in medical rescue

Multimedia solutions are currently widely used, both to educate medical staff and to patient education [1]. There are proofs that students of medical faculties have a high level of satisfaction, the feeling of self-effectiveness and achievement while using interactive environment online during education [2].

A significant development of telemedicine is also noticeable as it is widely used in medical rescue. Particular applications are successfully used in Emergency Rooms and their technical quality as well as satisfaction of the users are constantly increasing [3]. It is difficult to imagine how contemporary emergency medicine would function without digital interfaces, electronic databases, computer systems and graphical panel for servicing emergency devices such as cardiac monitors, pulse oximeters, capnographs, respirators etc. Medical rescue activities are often supported by digital systems, animations and multimedia sequences happening at a real time [4]. Implementation of interactive computer solutions in ambulances significantly improves the speed of electronic collection of data, enables voice service of the system and instant transmission of the patient's parameters to hospital emergency department [5].

Educating and evaluating medical rescuers

In most countries in the world, paramedics provide medical help in pre-hospital conditions. The first initiative aiming at preparing legal basis, training and allowing people who were not doctors to work at emergency ambulance services was undertaken in 1969 in Los Angeles. At that time, research on the effectiveness of non-hospital resuscitation and it was proved that it may be as effective when given by trained staff as when it is conducted by a qualified doctor whose education is much more costly. Thirty firefighters were invited to take part in a training entitled 'Mobile Intensive Care Paramedic' conducted in Harbour General Hospital [6]. Those were the first medical rescuers in the world, who obtained more and more qualifications do conduct invasive procedures which were allowed to be performed only by doctors and nurses at first.

Education in a paramedic work started in Poland in 1992. At that time paramedics were a pillar of System of Emergency Medical Service, especially in the United States and Great Britain [7,8]. Currently, the professional exam at the faculty of emergency medical care is carried out in various ways in Poland depending on a higher education institution. Evaluation criteria, test and practical tasks as well as the scope of knowledge are internal regulations of each school, which prevents reliable, comparable and standardized verification of professional qualifications of the future paramedics [9]. There is a project of the State Emergency Medicine Exam (SEME) whose first version was published on 19 August 2014, however, consultations on it still continue and the regulation has not come into force yet. The legislator assumes to conduct the written part of the exam using a computer device with software developed by *Medical Examination Centre*.

Reasonableness of the above assumption is confirmed by the research proving the effectiveness of using computed devices in teaching advanced resuscitation [10]. Additionally, the use of multimedia and interactive tasks allows us to assess the skills of non-technical students including awareness of the situation or the ability to make decisions [11]. These are types of competence that are necessary to the proper performance of medical actions which are determined in detail in normative acts [12]. There are no sufficient studies concerning modern techniques of evaluating medical rescuers.

The aim and assumption of the research

The aim of the research was to implement and critically evaluate the project of the SEME in Poland carried out with the use of multimedia computer devices. The authors conducted a comparative analysis of two forms of the exam: a traditional (paper) and interactive (computer) one in terms of participants' satisfaction and the obtained results.

The research tool that was used allowed us to achieve immediate results, keep statistics as well as to enrich the test with multimedia and interactive tasks used in the system of Computer Based Learning (CBL) [13]. Graphics, photos and audio-video materials presenting realistic simulations that is perceived as useful and satisfactory while teaching medical personnel [14]. Additionally, modern interactive solutions enabling the assessment of students' abilities were introduced.

MATERIAL AND METHODS

Participants of the research

The study was conducted at Collegium Masoviense at Higher School of Health Sciences in Poland. The participants were third-year students of undergraduate studies of the faculty of Emergency Medical Science (n=22). They followed the same curriculum before the exam, which mitigated the disturbing factor in a form of differences in the teaching contents. Before the start of the research, the participants signed the informed consent form.

Traditional test

The exam consisted of 45 closed questions, single choice, with four answer options. True-false and descriptive questions were not introduced as they were not recommended by other authors [15]. The test contained 4 graphics (ECG records and photographs of patients) The tasks were grouped into three types, in accordance with the programme of State written exams for medical rescuers in Canada [16]:

A – assessing the knowledge;

B – assessing knowledge application;

C – assessing critical thinking.

The authors chose thematic categories on the basis of a range of emergency medical actions which paramedics are entitled to perform:

1. Basic life support and automatic external defibrillation;
2. Advanced life support;
3. Opening airways with a use of tools;
4. Using cardiac monitors / defibrillators;
5. Performing and interpreting ECG;
6. Vessel cannulation and intraosseous infusion;
7. Pharmacotherapy in emergency situations;
8. Trauma assessment;

9. Dressing injuries;
10. Childbirth in pre-hospital conditions;
11. Medical segregation (disaster medicine);
12. Oxygen therapy and mechanical ventilation;
13. Acute cardiovascular conditions;
14. Acute neurological conditions;
15. Medical transport.

The test was constructed in such a way that each thematic category was included in all three types of questions (A, B and C). Time limit at 90 minutes was applied. It was possible to get one point for each task. Negative points were not given. Leaving a question unanswered did not cause any changes. The passing point of the test was 51% minimum.

Interactive test

The exam contained 60 tasks – four for each of the fifteen thematic categories included in the traditional test. The questions were grouped in a similar way (A, B and C) adding the fourth category – D comprising multimedia and interactive tasks. The applied formula enabled subsequent comparative analysis of both tests. The computer test lasted 90 minutes and the maximum number of points amounted to 100 as it was possible to score more than one point for questions from group D. Four questions from interactive tasks were designed in a form of 'conditional response'. The method was constructed in such a way to make it impossible for a student to go to further subsections of a question if they gave a wrong answer to the question at any level. Negative points were not given. . Leaving a question unanswered did not cause any changes. The passing point of the test was 51% minimum. The exam was conducted on multimedia computers in an IT laboratory of the school with prepared seats ensuring individual work. The most commonly used operating system was Windows 7 , recognized as the most frequently used by students of emergency medical rescue for educational purposes in their private use [17]. The computer allowed students to play audio and video files. The tasks included attachments in the form of files with photo, audio, video, forms to fill in, icons to match the 'blocks' as well as special fields of graphic 'hotpots' to insert marks (Figure 1).

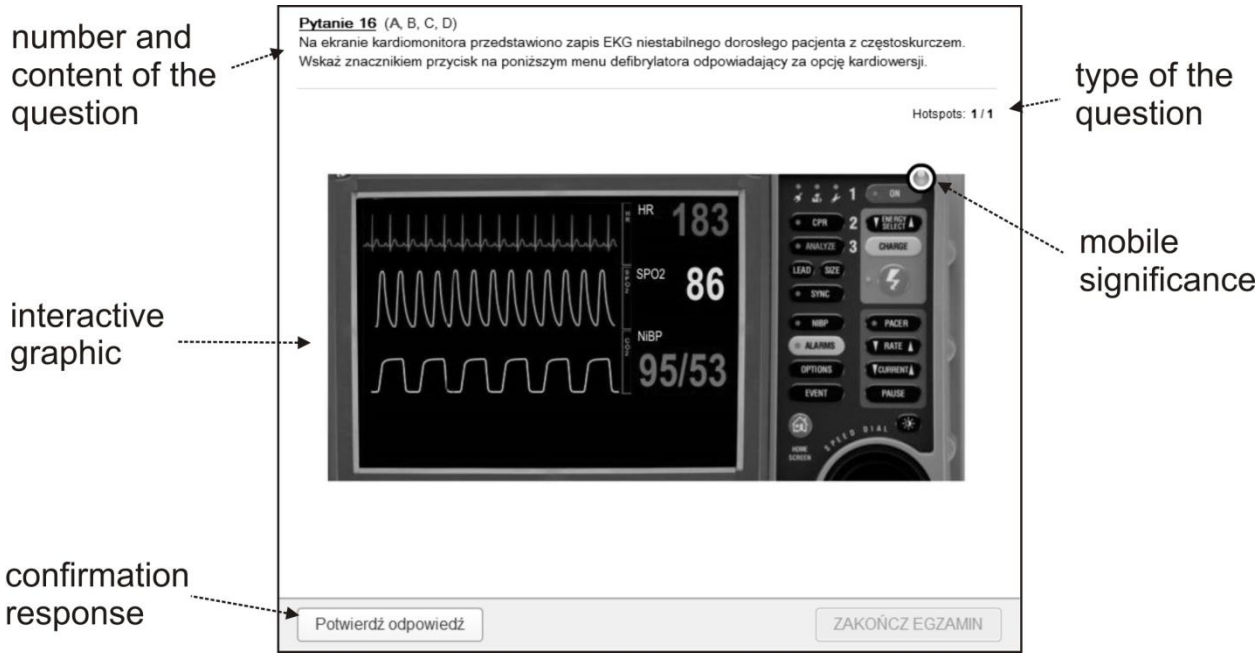

Figure 1. An example of an interactive task

Research tool

"iSpring Quiz Maker" programme was used to prepare the exam. The interface allows the implementation of original system of quizzes enabling the introduction of several question forms and interactivity (Figure 2). Each question may be improved and expanded by audio, video and photos. Adding slides with additional information to quizzes is also possible. It may make tests more attractive and add more clarity to them. The questions may be mixed or selected randomly from a pool of questions. Branched scenarios may be organized on the basis of participants' answers ('result answers'). Moreover, it is also possible to add individual opinion to a question, set the time limit, add final results or a number of attempts. The tests may be posted on each website, sent via e-mail or publisher in any SCORM/AIIC system conformable with Learning Management System.

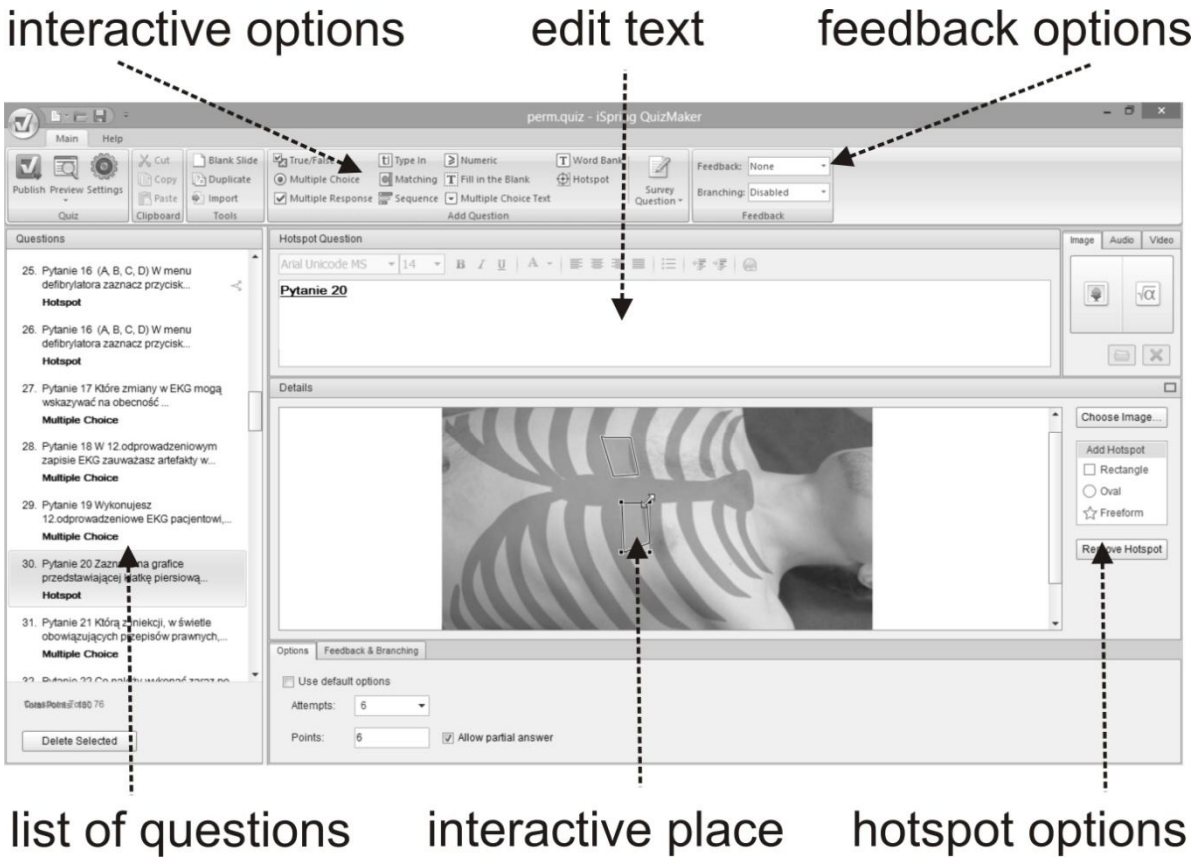

Figure 2. Interface of the research tool.

Data analysis

The results of the traditional test were analysed and compared to the results of the interactive test. To analyse the data and eliminate the changeability within the group, parametric tests were used to compare the results (T-Student test, T – test for dependent samples with Pearson's Correlation Coefficient) . Finally, a survey checking satisfaction of the test participants was conducted. The achieved results were analysed statistically at the significance level of $p < 0,05$.

RESULTS

Research participants

The research was conducted on 22 people (4 females and 18 males). Most of the participants (n=9) aged from 21 to 25 , constituting the youngest group. The oldest participants were at the age group of 41-45 (n=3).

Traditional test

The students achieved an average result of 59,09 % in the paper test (SD – standard deviation of ± 12,16). Taking into account the passing threshold of the exam at 51% , sic people did not pass the test. The results of the particular categories of the questions in average amounted to: A=53,47% (knowledge); B=50,24% (knowledge application); C=52,68% (critical thinking). Students achieved the highest results in tasks concerning trauma assessment (Me=82,00%; SD ± 9,00), and the worst results in intravenous 'cannulation, injections and intraosseous infusion' (Me=6,67%; SD ± 5,77). During the exam, there were no disturbances influencing individual work of the students. All the exam papers were handed in before the time limit of 90 minutes.

Interactive test

The students achieved an average result of 49,36 % in the interactive test (SD ± 17,61). According to all the set criteria, 10 students failed the exam. The results of the particular categories of the questions in average amounted to: A=54,27%; B=48,07%; C=54,07%; D=52,54% (interactive tasks). Students achieved the best results in tasks concerning trauma assessment (Me=76,75%; SD ± 12,82), and the worst results in intravenous 'cannulation, injections and intraosseous infusion' (Me=11,75%; SD ± 11,21). During the exam, there were no disturbances influencing individual work of the students. Three students did not manage to complete the exam before the time limit, however, the results they achieved were enough to pass the exam. Average time of taking the test amounted to 60,41 minutes (SD ± 15,21). Within the questions in category D, the highest score was achieved in question concerning Oxygen therapy (Me=95%), including a colourful graphics, whereas the lowest one students achieved in the question concerning ECG (Me=20%), containing animations of electric activity of the heart during a sudden cardiac arrest. In 5 cases , there were technical problems with audio files, therefore students were given maximum number of points in the questions in which they were not able to give the correct answer due to the problems.

Comparative analysis of the groups

The comparison of the groups taking into account three question categories (A, B, C) did not show any statistically significant differences (p=0,99 in T-Student test). Averages of the percentage results of both test forms, considering all question categories (A, B, C, D) indicated a statistically significant difference

in the test with two samples for averages, at p=0,001 (Table 1). Pearson's Correlation Coefficient at 0,726 confirmed a strong positive relation between the studied groups. In both tests, students achieved the lowest score in the question concerning cannulation, injections and intraosseous infusion (6,67% ± 5,77 vs 11,75% ± 11,21; p=0,47), and the highest in trauma assessment (82,00% ± 9,00 vs 76,75% ± 12,82; p=0,55), not indicating any statistically significant differences. Percentage analysis of the results for all fifteen thematic categories of the questions also did not show and statistically significant differences(p=0,47) between marks from the traditional and interactive test. The students who did not pass the traditional test were the same ones who did not pass the interactive test either. The exam conducted with the use of computers included additional four students whose test results were below the passing threshold.

Table 1. The comparison of the results of the traditional test and interactive one

(Paired samples *t*-tests with two samples for averages)

	Traditional test	Interactive test
Average	0,591	0,494
Variation	0,015	0,031
Observations	22,000	22,000
Pearson's Correlation	0,726	
Df	21,000	
t Stat	3,763	
P(T<=t) one-sample	**0,001**	
One-sample T Test	1,721	
P(T<=t) two-sample	**0,001**	
Two-sample T Test	2,080	

Satisfaction evaluation

The participants evaluated the interactive exam on a high level using 6-point scale (from 1 to 6). The highest score was given for detailed feedback (Me=5,95). The difficulty level amounted to the average of 5,18 (Table 2). In open questions, students mentioned the following advantages of the computer test: the quality of the video materials, interactive graphics, the speed of the achieved results and 'hotpot' tasks with

mobile markings. Drawbacks included: inevitably elapsing time which is displayed on the screen and technical sound problems. All the respondents stated that the SEME can be carried out with the use of multimedia computer devices.

Table 2. The evaluation of satisfaction after completing the interactive test.

Nr	Question content	score						Me
		1	2	3	4	5	6	
1	Evaluate satisfaction of participation in an interactive exam					8	14	**5,64**
2	Evaluate facility of the interface of the exam					7	15	**5,68**
3	Evaluate the speed of feedback					2	20	**5,91**
4	Evaluate the accuracy of the feedback					1	21	**5,95**
5	Evaluate usefulness of interactive questions					3	19	**5,86**
6	Evaluate the difficulty level of the exam					18	4	**5,18**

DISCUSSION

In Poland the theoretical part of the professional exams for medical rescuers is conducted mainly in the traditional form. However, It Has been proved that there are benefits of implementing computer exams that can operate virtually automatically for several years [18]. Educational institutions which use computer devices lack a standardized sample and the prepared tests contain only text questions and multiple answers. The exams do not contain any multimedia and interactive files and IT solutions are limited only to the opportunity of receiving test results quickly and conducting centralized statistics.

In the literature, there is no scientific data analyzing the effectiveness of electronic examinations at the faculty of emergency medical services. The authors of the research developed and attempted to assess the interactive tool for evaluating candidates for medical rescuers. The job of a paramedic is a key pillar of System of Emergency Medical Service in most countries in the world and it requires graduates to have specific knowledge, skills and to be highly qualified in implementing medical rescue activities in a state of danger to life and health [19]. Both the educational system and the testing system at the faculty of

emergency medical rescue should be based on modern solutions, the effectiveness of which is scientifically confirmed. The conducted study provides some evidence to support effective implementation of an interactive test in the field of medical rescue services.

The tool, prepared by the authors, contained the same questions for all students in the same order. The authors stated that a random selection of questions for each student from a previously prepared set of questions could be a factor forging the results in a computer test. The content of the questions in the interactive test was not the same but similar to the traditional test. In both forms of the exam, the questions were divided into three categories on the basis of the model of professional exams for emergency medical rescue in Canada. In both traditional test and the one conducted in a paper form, students achieved the lowest stores in tasks concerning knowledge application, whereas the highest marks concerned the knowledge of formulas and definitions. The average scores in questions in the categories ‘A’, ‘B’ and ‘C’ were in both tests comparable, therefore the reasons for statistically significant differences can be found in the task category ‘D’ –the interactive one.

The results show that the test carried out on computer devices helps to evaluate knowledge and competence in the field of emergency medical actions in a more detailed way. The number of students who did not pass the interactive exam was higher than in the test that was not based on a computer. Despite inevitably elapsing time visible on the screen mentioned by the students, this limitation was not the cause of lowering the level of performance in particular students. Problems with using the panel in a computer exam were not observed. Students had the biggest difficulties in both tests with a question concerning cannulation, injections and intraosseous infusion, whereas trauma assessment turned out to be the easiest. It proves that interactive questions containing graphics and multimedia evaluate students’ competence in the most reliable way compared to paper-based tests with multiple choice questions.

Other questions at which students scored less than 50% of the points in the traditional test concerned performing and interpreting ECG as well as pharmacotherapy in emergency situations. In the interactive test, students achieved less than 50% of the points in four thematic categories (despite previously mentioned ones): using cardiac monitors / defibrillators, childbirth in pre-hospital conditions, medical segregation and acute cardiovascular conditions. Both the task concerning cardiac monitors and

acute cardiovascular were constructed as a ‘result answer’, which led to not receiving further points when the student made a mistake in one of the first subsection of a question at a lower level of difficulty. Non-technical abilities of the students also allowed us to assess tasks concerning multimedia attachments. The example may be a question concerning a film presentation of the rate of chest compression. Almost 50% of students made a mistake in the question. The authors were astonished at such low results, as chest compression is one of the basic medical resuscitation actions, and the whole activity was recorded at a lateral projection, which is the most favourable for the visual assessment of resuscitation [20]. It may be concluded that the use of complex interactive tasks allows us to evaluate the competence of medical rescuers in a reliable way. The interactive test also enabled to assess the ability to locate particular structures on attached graphics with the use of ‘hotspots’, which was not possible in a traditional form of the test.

The participants highly assessed the project of the SEME in a computer-based test giving marks of 5 and 6 in six-point scale (1-6). In open questions of the final questionnaire, students expressed positive opinions about the system attributes providing quick and detailed results achieved after finishing the test, which was confirmed by the research of other authors [21]. The respondents indicated technical problems with playing audio files as a drawback, which could be the result of lack of updating controllers for external audio devices.

The achieved results encourage us to conduct further research and to implement interactive exams both in pre-diploma and continuous education of paramedics. Multimedia computer devices may be useful during the selection of candidates for medical studies , as a research concerning the facility, discriminatory ability of questions and reliability (Cronbach’s alpha) of entrance tests showed that there was a need to improve their quality [22]. The evaluation prepared in the appropriate way may be beneficial in the assessment of key competence of the candidates, both before and after the professional training of medical rescuers.

There is also evidence confirming the effectiveness of computer devices with an interactive program implemented into a standard process of the selection of patients at an admission room, which does not delay medical attention [23]. The consciousness of patients may be currently increased by doing

interactive tests online attached to courses concerning the process of medical treatment [24] or first aid [25]. E-learning tests supported by self-tests are also used in education at medical faculties [26]. The authors encourage implementation and evaluation of interactive self-tests during distant learning in the field of emergency medical actions.

CONCLUSIONS

The State Emergency Medicine Exam may be effectively conducted with the use of multimedia computer devices. Statistically significant differences between the results of a traditional test and CBL supported one show the possibility to achieve a more reliable verification of competence in the field of emergency medical actions thanks to interactive solutions. The high opinion of the satisfaction level of the participants of the computer test encourages us to conduct further research directed at defining the most effective method of assessing paramedics.

Disclosure statement

No potential conflict of interest was reported by the author's.

REFERENCES

[1] James JJ, Walsh L. E-health in Preparedness and Response. Disaster Medicine and Public Health Preparedness, 2011; 5(4): 257-258.
doi: https://doi.org/10.1001/dmp.2011.84

[2] Chan T, Sennik S, Zaki A, Trotter B. Studying with the Cloud: the use of online Web-based resources to augment a traditional Study group format. Canadian Journal of Emergency Medicine. 2015; 17(2): 192-195.
doi: http://dx.doi.org/10.2310/8000.2014.141425

[3] Ward MM, Jaana M, Natafgi N. Systematic review of telemedicine applications in emergency Rosom, Int. J. Med. Inform. 2015; 84 (9): 601-616.
doi: http://dx.doi.org/10.1016/j.ijmedinf.2015.05.009

[4] Lorenz E, Frank Ch. Significant improvement of the quality of bystander first aid using an expert system with a mobile multimedia device. Resuscitation. 2007; 74: 286-295.

[5] Anantharaman V, Han LS. Hospital and emergency ambulance link: using IT to enhance emergency pre-hospital Care, Int. J. Med. Inform. 2001; 61 (2-3): 147-161.
doi: http://dx.doi.org/10.1016/S1386-5056(01)00137-X

[6] Los Angeles Paramedic Program, Los Angeles: National EMS Museum Foundation, 2011 (accessed 07.07.16)
http://www.emsmuseum.org/virtual-museum/history/articles/399752-1969-Los-Angeles-Area-Paramedic-Programs

[7] Black J, Davies G. International EMS Systems: United Kingdom, Resuscitation. 2005; 64 (1): 21-29. doi: http://dx.doi.org/10.1016/j.resuscitation.2004.10.004

[8] Duszyński M. Efekty kształcenia w Polsce: perspektywa Brytyjska, Nuka 1. 2011: 137-144.

[9] Leszczyński P, Wejnarski A. Prospektywna ocena systemu edukacji i metod ewaluacji kwalifikacji zawodowych ratowników medycznych, Forum Oświatowe. 2015; 1 (53): 121-136.

[10] Thorne CJ, Lockey AS, Bullock I, Hampshire S, Begum-Ali S, Perkins GD. E-learning in advanced life support-an evaluation by the Resuscitation Council (UK), Resuscitation. 2015; 90: 79-84. doi: http://dx.doi.org/10.1016/j.resuscitation.2015.02.026

[11] Yeung J, Husselbee N, Davies R, Melody T, Lockey A, Gwinutt C, Bullock I, Gao F, Perkins G. Effect of non-technical skills teaching on performance – An evaluation of additional non-technical skills teaching in Resuscitation Council ALS course, Resuscitation. 2015; 96 (1): 24. doi: http://dx.doi.org/10.1016/j.resuscitation.2015.09.056

[12] Rozporządzenie Ministra Zdrowia z dnia 20 kwietnia 2016 r. w sprawie medycznych czynności ratunkowych i świadczeń zdrowotnych innych niż medyczne czynności ratunkowe, które mogą być udzielane przez ratownika medycznego, 2016 (accessed 07.07.16) http://isap.sejm.gov.pl/DetailsServlet?id=WDU20160000587&min=1

[13] Balacheff N, Kaput JJ. Computer-Based Learning Environments in Mathematics. International Handbook of Mathematics Education. 1996; 4 : 469-501. doi: http://dx.doi.org/10.1007/978-94-009-1465-0_14

[14] Johnsen HM, Fossum M, Vivekananda-Schmidt P, Fruhling A, Slettebo A. Teaching clinical reasoning and decision-making skills to nursing students: Design, development, and usability evaluation of a serious game, Int. J. Med. Inform. 2016; 94 : 39-48. doi: http://dx.doi.org/10.1016/j.ijmedinf.2016.06.014

[15] Bramley P. Evaluating training effectiveness. Maidenhead, McGraw-Hill, 1996.

[16] National Examination Study Guide. Canadian Organization of Paramedic Regulators, 2013. (accessed 07.07.16) http://admin.copr.ca/Uploads/Exam%20Study%20Guide%20v1.0%20FINAL%20Posted%20May18%202013_1.pdf

[17] Leszczyński P, Gotlib J, Kopański Z, Wejnarski A, Świeżewski S, Gałązkowski R. Analysis of Web-Based Learning methods in emergency medicine: randomized controlled trial, Arch. Med. Sci. 2015: 1-8. doi: http://dx.doi.org/10.5114/aoms.2015.56422

[18] Roszak M, Kołodziejczak B, Kowalewski W, Ren-Kurc A. Standard Question and Test Interoperability (QTI) – the evaluation of student's knowledge. E-mentor. 2013; 2(49): 35-40.

[19] Black J, Davies G. International EMS Systems: United Kingdom. Resuscitation. 2005; 64(1): 21-29.

[20] Jones A, Lin Y, Nettel-Aquirre A, Gilfoyhle E, Cheng A. Visual assessment of CPR quality during pediatric cardiac arrest: Does point of view matter? Resuscitation. 2015; 90 : 50-55.

[21] Półjanowicz W, Roszak M, Kołodziejczak B, Bręborowicz A. An analysis of The Effectiveness and quality of e-learning in medical education. In: E-learning and Intercultural Competences Development in Different

Countries, Monograph Sc EditorEugenia Smyrnova-Trybulska, Uniwersity of Silesia, Studio-Noa, Katowice-Cieszyn. 2013: 177-196.

[22] Panczyk M, Belowska J, Rebandel H, Gotlib J. Jakość testowego egzaminu wstępnego na kierunek położnictwo studia drugiego stopnia – 5 letnia analiza retrospektywna. Pielęgniarstwo XXI wieku. 2016; 1(54): 22-26.

[23] Benaroia M, Elinson E, Zernke K. Patient-directed intelligent and interactive computer medical history-gathering systems: A utility and feasibility study in the emergency department, Int. J. Med. Inform. 2007; 76 (4): 283-288.
doi: http://dx.doi.org/10.1016/j.ijmedinf.2006.01.006

[24] Tait AR, Voepel-Lewis T, Chetcuti SJ, Brennan-Martinez C, Levine R. Enhancing patient understanding of medical procedures: Evaluation of an interactive multimedia program with in-line exercises, Int. J. Med. Inform. 2014; 83 (5): 376-384.
doi: http://dx.doi.org/10.1016/j.ijmedinf.2014.01.011

[25] Chęciński I, Zyśko D, Smereka J, Gajek J, Miceska-Świerzko J, Ściborski R, Brodzki M, Wróblewski P, Czyrek A, Agrawal AK. The Presence of Agonal Respiration During Cardiac Arrest and Resuscitation Attempts by Witnesses. Advances in Clinical and Experimental Medicine 2011; 20(6): 761-765.

[26] Kołodziejczak B, Roszak M, Ren-Kurc A, Bręborowicz A, Kowalewski W. Creating digital question databases: Use of self-tests in teaching medical subjects . Studies in Logic, Grammar and Rhetoric. 2015; 43(56): 221-227.
doi: http://dx.doi.org/10.1515/slgr-2015-0051