OPEN ACCESS Freely available online

Emergency Medicine: Open Access

Research Article

Virtual Reality Practical Applications Utility in a Context of Field Hospital Training Programs

Emilia Turucz *, **Sorana T. Truța, Ernő Jerzicska, Cristian M. Boeriu, János Szederjesi, Leonard Azamfirei**

Department of Applied Medical Sciences, University of Romania, Romania

ABSTRACT

Introduction: Training is a key element in ensuring quality patient care for emergency medical teams. Within the framework of the European Modular Field Hospital project, a prototype of a complex educational program was developed, which is aimed at preparing field hospital personnel for real missions.

Objectives: This is the first study to use virtual reality-based simulation exercises in this context. The goal was to assess these complex virtual simulation exercises in terms of their usefulness and applicability.

Methods: The program prototype was tested in a multinational multidisciplinary real educational environment as part of two pilot courses. The evaluation consisted of online questionnaires that separately addressed each educational activity. The course content, structure, and simulation exercises were continuously developed according to feedback.

Results: 76 trainees from eight countries participated in the two pilot courses. Of the participants, 63.9% said that the method was suitable for conducting such exercises. Its technical use is "easy enough" to learn (59.7%) and provides an interactive (90.32%) and realistic (25.0%) working environments.

Discussion: Our assumption that virtual reality is a usable method in this context was supported by participants' feedback. The visual impact of the virtual environment enhances the psychical immersion of trainees in practical activities. Over time, these cyberspace experiences have become real professional memories and contribute to the long-term preservation of knowledge.

Conclusions: Virtual reality is a promising educational tool that can complement expensive and laborious field exercises. It provides an interactive, realistic, and immersive simulation environment supported by comparable resources.

Keywords: virtual reality, disaster medicine, field hospital, simulation exercises

INTRODUCTION

Units and medical teams specializing in disaster relief are ethically responsible for providing the best possible medical care for the disaster-affected community. In this sense, it has become necessary to create a culture of knowledge exchange among humanitarian agencies to view disaster-relief procedures from a holistic and multidisciplinary perspective. A complex and integrated relief-package that is quickly accessible to the affected community may significantly reduce disaster losses.

On the basis of these principles the concept of the European Modular Field Hospital (EUMFH) has come into being that is aimed at enhancing the capacity of the deployable medical units of the United Civil Protection Mechanism (UCPM). According to the World Health Organization's categorization, the European Modular Field Hospital corresponds to an emergency medical team level 3 (EMT 3), and according to the NATO doctrine to a ROLE 4 field hospital.

Through a European Union project, the concept of the EUMFH was developed, as a first step focusing on elaborating the

Correspondence to: Turucz E, Department of Political Science, University of Botswana, Botswana; Tel No: 0727458335; E-Mail: eturucz@gmail.com

Received date: February 16, 2020; **Accepted date:** August 25, 2021; **Published date:** September 07, 2021

Citation: Turucz E (2020) Virtual Reality practical applications utility in a context of field hospital training programs. Emergency Med 10: p005

founding and operating guidelines of the unit. During the two years of the project, specialists from different countries were working in parallel in four different domains of development: define standard operational procedures (SOPs), logistics, staff profile, training, and exercises. The Directorate for Emergencies of Romania (DSU) took on two challenges: elaborating the guidelines for staffing and developing a training plan for them. Within the project, our research team was responsible for the elaboration of virtual reality-based workshops.

The main objective of the training courses consists in preparing the field medical units' to conduct medical care as best as possible in an unknown and potentially dangerous conjuncture of a disaster area. The training plan must include refreshing courses to maintain skills and additional educational activities in order to improve their performance. Both individual competences and team dynamics are key factors in the efficient functioning of a mobile emergency unit. Real missions seldom occur, but due to this fact, it is even more important to sustain key competencies through a well-established long-term training program, so that these competences are updated in due time, thus also maintaining the staff's motivation and interest in participating in real missions.

Virtual reality constitutes a virtual environment generated by a computer in which trainees may practice individually or in teams to work their disaster relief activities enhanced by different levels of sensory and psychological immersion in a safe but, at the same time, close to reality stress situations. Therefore, it is often used in training related to disaster management operations. It is primarily used for developing specific individual competencies, for enhancing teamwork and collaboration, as well as for evaluation and assessment of technical skills [1, 2].

Currently, for setting up virtual reality-based simulation exercises, we have access to several technical tools from simple computer-based three-dimensional software to complex technologies that offer a complete deconcetion from reality. Their practical application spectacularly and, last but not least, cost effectively increases the performance of educational programs as well as the success of knowledge transfer [3]. Experiences gained in a virtual environment are stored by the mind, similar to real professional experiences, and thus they greatly influence the long-term preservation of learned skills [4, 5, 6].

Within the EUMFH project, a context-specific basic training program has also been developed. The practical application of the workshop is primarily based on simulation exercises in virtual reality. The aim of this study is to assess the usefulness and applicability of simulations in virtual reality in the EMT training process and to evaluate the integration potentials of the method in this special educational environment.

METHOD

Worldwide, there are several national and international training programs for specialists in disaster relief. In master's programs or short trainings offered by different universities, training agencies or international organizations that are interested may widen their professional skills and gain new, context-specific knowledge and skills. These online or offline courses often offer either too large-scale information or are highly specialized. At the same time, the methodology of these courses is mainly based on theoretical lectures, media learning materials, and case studies; for practical applications, they mainly use tabletop or situational exercises and role playing. Occasions for real-field training seldom occur. Neither of the existing educational programs covers the full complexity of the training needs of an EMT level 3 unit staff.

Therefore, the EUMFH project's team responsible for training set as one of its main goals is the elaboration of the prototype for a comprehensive context-specific basic training program that can easily be adapted for the basic training of any type of field emergency unit. As a first step, the team has assessed and compared the contents and structure of all the existing education programs in this domain, and then they have organized the knowledge-packages depending on whether they require online or offline, theoretical or practical teaching methods, and how often the information needs to be updated. Finally, the team elaborated on the content and structure of the prototype of a „face-to-face" (F2F) training program that has been tested in the course of two pilot workshops in a real educational setting.

The selection of participants for the two courses met the set criteria. Our aim was to first apply the program prototype with multinational and multidisciplinary groups whose members have different levels of field experience. Ten specialists from eight countries participated in the workshop. Each group had its own leader, medical staff, pharmacist, and logistics specialist. In order to have balanced and comparable groups of training audience for both of the pilot courses, we carefully selected them on the basis of their professional and mission-experiences and from the perspective of their specialty and nationality.

We also followed set criteria for the selection of the instructor team, where high-level professional knowledge, field experience, and educational skills were considered indispensable. The trainers chosen specifically for the different topics elaborated the theoretical and practical activities necessary for the transmission of the given knowledge packages based on the aims and guidelines previously set out by our team.

The schedule of the prototype workshop remained flexible throughout and was formed dynamically based on the participants' feedback. On each day of the course, participants received an online evaluation questionnaire that addressed each educational activity performed on different days of the workshop. Thus, the course was constantly changed and improved from one phase to the next.

The practical workshops were composed of interactive case studies, role playing, tabletop exercises, and simulation exercises in virtual reality. In elaborating the workshops, we followed the basic concept of designing a fully transportable and adaptive course setting. This EUMFH basic training course should be able to run anywhere and even among rudimentary circumstances.

Finally, the program contained three virtual reality-based practical workshops. These were preceded by a brief

introduction to the existent and possible applications of virtual reality in disaster relief. We used the XVR simulation software (www.xvrsim.com) to set up a virtual environment, which is a desctop-based, interactive simulation program that allows us to generate any type of 3-dimensional disaster environment. The set up cyberspace could be used concomitantly by several participants in such a way that perceiving and interacting each other in real time within the generated environment. At the same time, events and interventions taking place in the virtual space could be observed immediately, and they produced chain reactions as if in reality.

The application of the software and all the necessary technical equipment and technical staff were provided by the National Simulation Center for Emergency Situations of Targu Mures. The technical running base of the simulation system consists of 20 computers, routers, and structured cabling, as well as portable furniture. The system can be delivered in its entirety and used for simulation exercises under any circumstances.

The two courses were organized into two different cities under different circumstances. The first workshop took place in Targu Mures in the above-mentioned simulation center, the second in Timisoara, in the rented reading rooms of the local Technical University's Central Library.

The structure and methodology of the VR workshops are illustrated in Table 1. As mentioned above, the practical workshops were preceded by a lecture on virtual reality in the course of which we discussed the relevant technical and educational aspects of the method, and presented some practical applications of virtual reality in disaster relief related training programs. After the lecture, the participants were familiarized with the technical aspects and use of the simulator.

During the first workshop, exercise trainees were divided into smaller groups and were given the task of building level 3 modular field hospitals in the virtual space. Later they also had to present in the course of virtual sightseeing. At the end of the workshop, we discussed the achievements and chose the most suitable prototype structure.

The following two workshops consisted of full-scale simulation exercises conducted in VR, and the scripts of the virtual simulation exercises were elaborated on the basis of the full-scale field exercise guidelines, and they were validated by an independent team of specialists. The special virtual environment was set up by the team of XVR from Targu Mures under the guidance and manifold collaboration of our research team.

Table1: Methodology and structure of exercises performed in the virtual environment

	Exercise no. 1	Exercise no. 2	Exercise no. 3
Aims	EUMFH modeling, building virtual prototypes	Testing the functionality of EUMFH	Reorganizing EUMFH resources and managing reserves in case of isolation
	Revealing the structural and functional complexity of the field hospital	Application and testing SOP's	Adaptation for sudden high patient inflow
		Practicing coordination, communication and collaboration processes	Practicing coordination, communication and collaboration processes
Methodology	Teamwork of 5-7 people: elaborating 3D EUMFH structures	Complex, full-scale, virtual reality simulation exercise	Complex, full-scale virtual reality simulation exercise
Expected results	Setting up EUMFH prototypes in virtual space	Practicing EUMFH SOP's	Interdisciplinary collaboration
	Team discussion of the optimal structure of an EUMFH type field hospital	Testing SOP's, searching issues to improve, exploring special needs	Fast reorganization of resources, and planning alternative solutions in extreme circumstances
		Practicing multinational and multidisciplinary collaboration and teambuilding	Fastening reaction time, developing non-technical skills and flexibility

In addition to the daily online questionnaires, we also used two fill-in questionnaires to evaluate the virtual reality-based workshop exercises. The questionnaires were composed of single and multiple choice questions, Likert rating scale (3, 4, and 5 grade), matrix table, and open-ended questions. The content of the questionnaires was also assessed and validated by an independent team of specialists.

The SPSS v23.0 software package was used for statistical processing of the data. Basic descriptive statistics, contingency table, chi-square test, and t-test were applied. For all analyses, the statistical significance was set at $p < 0.05$ or lower level.

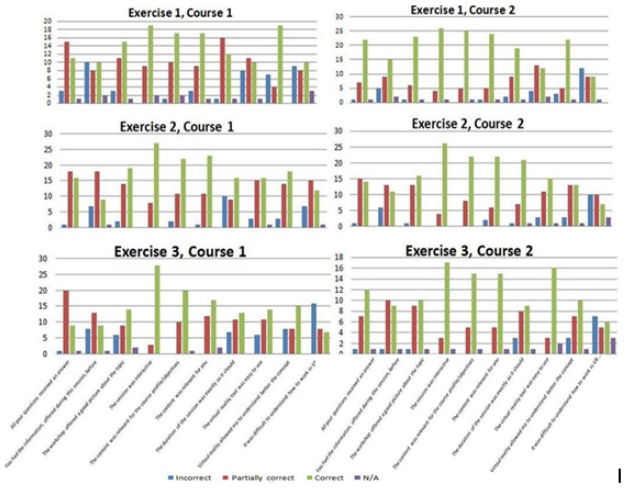
RESULTS

In the two trial courses, 76 trainees participated all together from 8 countries. The composition of the staff was as follows: 34,7% medical doctors, 36% nurses/paramedics, and 29,3% specialists in logistics. Considering the participants' prior field experience, 10,7% of the trainees had no field experience, 32% had already participated in field exercises, and 37,3% of them in

real missions. Furthermore, among the participants of the two courses, an average of 42,7% had some teaching experience as well. Based on the basic descriptive statistical processing, it can be stated that the composition of the two pilot training programs is representative and comparable from the perspective of the target population.

Figure no. 1 illustrates the assessment of the three-three virtual workshop exercises conducted during the two trainings. In the course of all the exercises virtual reality proved an interactive simulation environment, in the case of exercise no. 3 achieving a 90,32% positive feedback rate for this aspect (p=0,0129). To the question to what extent the virtual environment contributes to the understanding of the EUMFH concept we also received significant positive feedback, especially after exercise no. 1 (63,33% and 70,97%); though this rate decreased during the two full-scale virtual simulation exercises (51,43% and 43,33%, respectively 48,39 and 47,62), but this decrease was not statistically relevant (p=0,244 and p=0,0926). A further important question asked to what extent we managed to provide a comprehensive and clear picture of the topic in the course of the virtual simulations. In this sense we succeeded in significantly improving exercise no. 1 in the case of the 2nd course (50,0% vs. 74,19%, p=0,05). Exercises 2 and 3 received lower grades in this sense as well; however, these lower grades were not significant.

Figure1: Evaluation of virtual reality based exercise-series



For 66,7% of the trainees, this was the first time they participated in a simulation exercise conducted in a virtual environment; accordingly, answers to the question related to prior expectations showed the following results: 30,7% expected interactive simulation exercises, 16,0% teamwork training and interdisciplinary collaboration, and only 12,0% of them expected reality-like simulation environments. At the end of the practice series, however, 25,0% of the participants answered that the virtual environment reproduced the reality-like sense of field practice (p=0,0403). Participants identified two characteristics as the weak points of the simulation exercises: the low number of practical maneuvers that can be conducted in the virtual environment (15,3%), and the uncofortably compresed exercise time (15,3%).

From the perspective of userfriendly tehnical interface 59,7% of participants thought that the technical use of virtual reality is "easy enough" to master. This is also sustained by the outstanding number of „correct" answers in figure 1. with reference to the simplicity of simulator usage. On average, the simulation exercises conducted in the virtual environment corresponded to the prior expectations of the participants (56,9%). Regarding the question of whether virtual reality was appropriate for such simulation exercises, 63,9% of participants said yes, but out of these, 25,0% also said that further technical adaptation would be necessary, and the other 25% highlighted the need to refine the process of conducting these exercises, especially regarding the flow of information coming from the instructors and virtual space.

The last group of questions addressed the assessment of virtual simulation exercises as compared to tabletop exercises and full-scale field practice. In this comparison, we considered the most important features of the practical workshops in this context: realistic simulation environment, interactivity, developing technical and non-technical skills, practicing teamwork, and interdisciplinary collaboration. We also search for trainees' opinions regarding the planning and organizing complexity and cost efficiency of these practical application. The results are shown in figure 2.

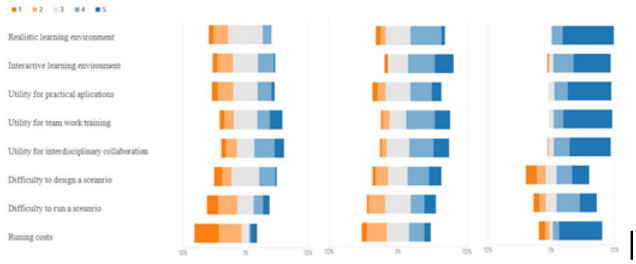
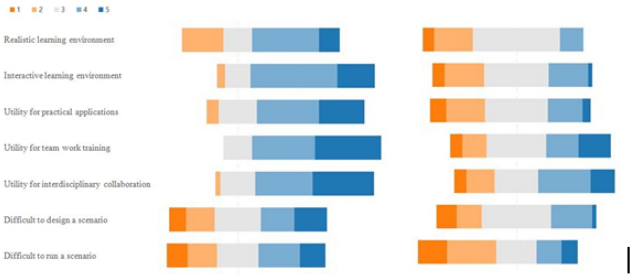


Figure3: Apreciation of tabletop exercises before and after virtual simulations



DISCUSSION

The virtual reality-based full-scale simulation exercises elaborated in the EUMFH project were used for the first time in the world in the context of an EMT training program. In the course of the two pilot instructional programs, the main goal of our research team was to assess the possibilities of applying virtual reality simulations in the given type of educational environment. Therefore, we set up a multinational, multidisciplinary trainee community that was representative from the perspective of the target population, which was also proven to have diverse levels of real mission experiences.

One of the most important elements of practical workshops and exercises is the execution of real practical maneuvers, which are the most expensive parts of the exercises because of the demand for simulating reality. In other way arround, to organiz and coordiante these interventions, to provide the necessary resourses and equipments, and to assess properly the consequences carried on the concepts of critical thinking are just as important as the operations themselves. These skills can be best developed through large-scale simulation exercises [7, 8, 9]. For this purpose, full-scale field exercise is the most suitable, but access to field practice is limited due to the high complexity of organizing them as well as their high costs. Thus, practical workshops are most often based on tabletop exercises. These exercises provide a comprehensive image of the fieldwork procedures and the chain of comand and control. Participants can practice applying standard operational procedures, coordination and communication processes, interdisciplinary collaboration, and teamwork. A basic requirement of high-quality simulation exercises is an interactive, realistic, and multilayered practicing environment where the psychological and physical stress effects of deployments are reproduced as faithfully as possible [6].

We assume that the simulation exercises conducted in a virtual environment meet these expectations. Even more, virtual reality is enhancing the benefits of tabletop exercises, by the fact that the visual impact of the realistic virtual environment and the free interactions within, significantly strengthens the participants' psychical and emotional immersion in their practical activities. The trainees' opinions, all together from the two courses, supported our hypothesis with 56,9% positive answers (p=0,0077) for the question regarding the utility of virtual simulation exercises in their training process. At the same time, the assessment also shows that virtual simulation exercises need further development and adaptation in both technology and exercise conduction, which is emphasized mainly by specialists in logistics. Many answers to the open questions suggested that we should continue the development of virtual reality simulation exercises given that it promises to be "a very good educational tool."

The exercise series conducted in virtual reality posed a challenge to both trainers and trainees, given that it was applied for the first time in this form. The realistic environment and lifelike events occuring in the virtual space enhance the psychological stress effect [10, 11]. This is further strengthened by the fact that interventions that are time-consuming in real life have a much faster pace in the virtual space, and consequences can also be assessed much faster. All these fasten the rhythm of exercises; one has to proccess much more information in a shorter time and decisions need to be made more frequently. A low number of trainees (15%) mentioned this as a negative feature. The rest of the participants, however, enjoyed throwing themselves into the spin of events. At the same time, virtual exercises offer more professional experience in a shorter timespan, owing to the increased rhythm and the stress effect, which enhances reaction time, flexibility, and critical thinking more efficiently [12].

Over the two courses, practical workshops based on VR applications were gradually improved. This is also shown by the trainees' opinions (Fig. 1). All exercises were completed with an exercise debriefing and joint assessment of the training method. At the end of the worksop series, a final questionnaire was also handed out. The workshops and the simulation exercises were continuously changed according to the feedback given by trainees and trainers, and this is reflected in the change of opinions by the end of the exercise series or when we compared the same exercise of the two courses .

Exercise no.1 differs from the other two full-scale simulation exercises in its methodology, given that in this case, trainees divided into smaller groups are asked to build a field hospital in the virtual space. The joint vitual walk in the set up virtual hospitals contributed significantly to understanding the EUMFH concept and revealing its organizational and operational complexity. So-called „design" exercises have been shown to facilitate and increase the efficiency of knowledge transfer [13]. By the time of the second workshop, the team conducting the exercise had already gained more experience, and this is also reflected in the assessment of the exercise: they were able to answer a much larger number of posed questions (p=0,008), and they performed better in providing a comprehensive image of the topic (p=0,05).

The main goal of the first large-scale vitual simulation exercise (Exercise no. 2) was to apply and test the standard operational procedures developed specifically for the setting of EUMFH. The virtual field hospital was populated by virtual patients whose care was provided by the trainees with theoretical applications of the corresponding real procedures. Thus, an interactive, lively educational environment was created where virtual reality and real physical interactions merged unnoticed. Trainees immersed entirely into the virtual hospital's life while they were truly applying and experiencing the operational regulations of a field hospital. In the course of the second workshop, we managed to improve this exercise as well, as shown by the significant change in positive responses with respect to the length of the simulation (p=0,05).

In the course of Exercise no. 3, beyond the basic procedure, we were also practicing fast reorganization and troubleshooting in an already familiar virtual environment. In addition to the optimal usage of limited resources and equipment supplies, the main goals were to enhance reaction time, critical thinking, and cope with extreme and stressful situations. The EUMFH was suddenly forced to handle mass patient admission, while stock replenishment resources were stopped. The hospital was thus forced to handle the situation with the existing resource equipment stock. The trainees were quickly immersed in the already known virtual hospital life. They were better and better at using all the practice opportunities offered by this training environment, they routinely organized themselves, collaborated with each other, and worked together to develop solutions. Significant changes were registered for the question related to the easy technical usage of the simulator (Course no.1, exercises 2 vs. 3, p=0,054) and referring to the exercise conduction in the virtual environment (Course no.2, exercises 2 vs. 3, p=0,0076).

Some of the trainees considered the virtual simulation exercises to be widened tabletop exercises given that real interventions after the assessment of the situation in the virtual space

depended on the trainees only until decisions had been made. At the same time, they appreciated the immediate and realistic visualization of the practical consequences of events or practical decisions. The mulitsenzorial information package imported into the virtual space significantly enhances the professional experience gained through the exercises and their transformation into long-term real professional experience [5, 12].

After having experienced the advantages offered by virtual reality, the participants significantly downscored the quality of tabletop exercises. Simulations in the virtual space are capable of reproducing among classroom conditions the realism and stressful atmosphere of a full-scale field exercise[14]. Virtual reality is a promising educational tool that may complement disaster-related field exercises in a cost-efficient manner, approaching its educational effectiveness [14, 15]. Furthermore, simulations in virtual reality can be repeated as many times as needed, and once a virtual scene has been created, it can be endlessly reused. Exercise-conducting packages can be easily adapted to meet the expectations of other training objectives or new target groups without additional costs.

CONCLUSION

The prototype course elaborated within the framework of the EUMFH project is unique from several perspectives. This is the first educational program worldwide that focuses on the training of field hospital staff and offers a complex and comprehensive knowledge package to those interested in the domain. The use of virtual reality for the setting up of a full-scale simulation exercise also constitutes a world premiere. The assorted training audience demonstrates varying professional experiences in the course of the two pilot training programs put under serious testing of both the course content and the possibilities offered by virtual reality. With reference to further developments, assessment questionnaires, group discussions, and professional observation provided multiple valuable ideas.

Both trainees and trainers clearly enjoyed using virtual reality. Participants adapted quickly to the new form of practice, both from the perspective of technical usage and the combined, virtual, and real information flow of the simulations. Virtual simulations that evoke the working conditions and atmosphere of field practice provide the possibility for exercises that are more transparent, easier to coordinate, and which can be repeated as needed; they can also be conducted among safe classroom conditions, involving less costs and less organizational troubles, with an educational efficiency approaching that of field exercises.

The sensory impact of realistic locations and events in the virtual space enhances the urge for physical interventions. In contrast, in the case of tabletop exercises, it seems almost natural for technical maneuvers to remain at the level of decision-making. Thus, many participants expressed their dissatisfaction with the number of maneuvers implemented in the virtual environment. Actions performed in cyper space require a technically more complex system, and disaster scenes and events whose details are more elaborate. Currently more developed virtual simulation systems that would allow more interaction and deeper immersion or would provide a complete deconection from reality are still very costly, less flexible, and in the elaboration of the virtual environment, they require much more time and effort. However, higher immersion in the virtual environment or more realistic interaction does not necessarily mean more intense knowledge transfer [16]. Finding the optimal balance between the lifelikeness of the virtual simulation environment and educationale efficiency requires further research.

REFERENCES

1. Cone DC, Serra J, Kurland L. Comparison of the SALT and Smart triage systems using a virtual reality simulator with paramedic students. Eur J Emerg Med. 201; 8:314-321
2. Knight JF, Carley S, Mackway Jones K. at all. Serious gaming technology in major incident triage training: A pragmatic controlled trial. Resuscitation, 2010; 81: 1175-1179
3. Leder J, Horlitz T, Schütz A. at all Comparing immersive virtual reality and powerpoint as methods for delivering safety training: Impacts on risk perception, learning, and decision making. Saf Sci. 2019; 111: 271–286
4. Chittaro L, Buttussi F. Assessing Knowledge Retention of an Immersive Serious Game vs. a Traditional Education Method in Aviation Safety. IEEE. 2015;21(4):218.
5. David D, Matu SA, David O. Psychology and technology. Fundamentals of robotics and psychotherapy through virtual reality. [Psihologie și tehnologie. Fundamente de roboterapie și psihoterapie prin realitate virtual]. POLIROM Könyvkiadó, Bukarest, 2015
6. Pucher P.H., Batrick N., Darzi A. at all. Virtual-world hospital simulation for real-world disaster response: Design and validation of a virtual reality simulator for mass casualty incident management. Journal of Trauma and Acute Care Surgery. 2014; 77: 315-321
7. Abbasi M, Salehnia HM. Disaster Medical Assistance Teams After Earthquakes in Iran: Propose a Localized Model. Iranian Red Crescent Medical Journal. 2013; 15: 829-35
8. Cohen D.C., Sevdalis N., Darzi A.W at all. Major incident preparation for acute hospitals: Current state-of-the-art, training needs analysis, and the role of novel virtual worlds simulation technologies. Journal of Emergency Medicine. 2012; 43: 1029-1037
9. Gout L, Hart A, Bounes V. at all. Creating a Novel Disaster Medicine Virtual Reality Training Environment. Prehosp Disaster Med. 2020; 35: 225-228
10. Mantovani F, Castelnuovo G, Gaggioli A, Riva G. Virtual Reality Training for Health-Care Professionals. CyberPsychology Behav. 2003 Aug 5;6(4):389–95
11. Ferrandini M.P., Escribano T.D., Juguera R.L. at all. Comparative study of a simulated incident with multiple victims and immersive virtual reality. Nurse Education Today. 2018, 71:48-53
12. Mills B., Dykstra P., Hansen S., Danielle Bartlett D. at all. Virtual Reality Triage Training Can Provide Comparable Simulation Efficacy for Paramedicine Students Compared to Live Simulation-Based Scenarios. Prehospital Emergency Care. 2019; 24:1-16-costefectivness, better simulation
13. Chen SY; Lai YH; Lin YS. Research on Head-Mounted Virtual Reality and Computational Thinking Experiments to Improve the Learning Effect of AIoT Maker Course: Case of Earthquake Relief Scenes. Front Psychol. 2020; 11: 1164-1171

14. Farra S., Miller E., Timm N., Schafer J. Improved Training for Disasters Using 3-D Virtual Reality Simulation. Western Journal of Nursing Research. 2013; 35: 655-671

15. Ingrassia P.L., Ragazzoni L., Carenzo L., Corte F.D. at all Virtual reality and live simulation: A comparison between two simulation tools for assessing mass casualty triage skills. Eur J Emerg Med. 2015; 22:121-127

16. Bowman, D.A., & McMahan, R.P. Virtual reality: how much immersion is enough? Computer. 2007; 40: 36–43.