ORIGINAL ARTICLE

# THE APPLICABILITY OF VIRTUAL REALITY IN CARDIOPULMONARY RESUSCITATION TRAINING – OPINION OF MEDICAL PROFESSIONALS AND STUDENTS

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**Key words:**
virtual reality, cardiopulmonary resuscitation, medical training.

## Abstract

**Introduction:** Thanks to the dynamic technological development, evolution of medical education has become more rapid over the last fifty years. One of the latest teaching tools used in medical training is virtual reality (VR).

**The aim**: The aim of the study was to analyze impressions of medical professionals and students on the applicability of demonstrative software designed for CPR education in VR.

**Material and methods:** Among 784 participants of the 11th Emergency Medicine Conference "Copernicus 2017", 90 took part in workshops. 83 of them voluntarily attended the study. Each participant performed a two-minute virtual cpr scenario on a manikin and expressed their opinion in post-training questionnaire.

**Results:** 88% of respondents assess the educational value of VR in first aid training and medical simulation as good and very good (95 CI 0.79-0.94; $z = 6.81$; $p < 0.01$). 77% assess the credibility of sudden cardiac arrest symptoms presented in the prototype as good and very good in comparison to the solutions they have known so far for (95% CI 0.68-0.86; $z = 4.81$; $p < 0.01$). 73% think that first aid and medical training in VR can be more effective than traditional education with the use of standard manikin (95% CI 0.63-0.83; $z = 4.08$, $p < 0.01$).

**Conclusions:** So far, no ideal training method has been developed for effective sudden cardiac arrest recognition and providing high-quality resuscitation. Scientific reports on the use of VR for this purpose are promising. However, despite the initial, positive feedback, this issue requires more detailed research.

## INTRODUCTION

Medical education, like medicine itself, has been evolving for centuries [1]. Thanks to the dynamic technological development this process has become more rapid over the last fifty years. One of the latest teaching tools used in medical education is virtual reality (VR) and augmented reality (AR). VR and AR applications are already used in surgery, diagnostics and pain management [2, 3]. In psychotherapy, where it is used to treat anxiety disorders, it is beginning to be one of the most effective ways to conduct therapy through exposure [4]. VR enables simultaneous training of practical skills, soft skills and stress management. As a result, it might become an excellent instrument for teaching in the field of first aid, emergency and disaster medicine [5]. In human population one of the most commonly taught skill associated with life-threatening condition is cardiopulmonary resuscitation (CPR). This applies to both medical personnel and lay responders. It is well established that bystander high quality chest compressions and early defibrillation are the main determinants of survival in sudden cardiac arrests (SCA). There is also some evidence that the introduction of training for lay responders was associated with higher survival rate in SCA at 30 days and 1 year [6, 7]. From this perspective, the improvement of CPR learning outcomes seems to be crucial. Due to the innovative nature of the subject, there are very few scientific reports regarding the impressions of medical personnel and students. Also the impact of VR use on the effectiveness of resuscitation training is not scientifically obvious. This prompted us to take an interest in the opinion of medical professionals and students on the applicability of one of the latest software designed for CPR education in virtual reality.

## THE AIM

The aim of the study was to collect and analyze impressions of medical professionals and students on the potential usefulness of demonstrative software designed for CPR education in virtual reality.

## MATERIAL AND METHODS

Among 784 participants of the 11th Emergency Medicine Conference Copernicus (Poland, Lodz 17–19.11.2017), 90 took part in workshops. Eighty

three of them voluntarily attended the study to evaluate the beta version of cpr virtual reality learning software – "VR ACT" (by Octopus VR, Lodz, Poland). Participation in the study was voluntary. The "VR ACT" software was implemented for HTC Vive (HTC, Taoyuan, Taiwan). Each participant practised a two-minute virtual scenario, simulating a SCA, which occurred in the presence of witnesses. The elements presented in the scenario included: a scene where the victim of cardiac arrest collapses on the sidewalk, gasping, cyanosis, gathering of virtual witnesses of the event. Every participant of the study could assess the state of consciousness, the presence of breath and designate a bystander to call an ambulance. Vital signs assessment and chest compressions were performed on the standard cpr manikin (Resusci Anne Basic, Laerdal Medical, Norway) which was integrated in the virtual space and covered with virtual 3D-human model – avatar. It enabled to achieve realistic haptic feedback and hands-on training. Every scenario ended with the arrival of an ambulance two minutes after the virtual victim collapsed on the sidewalk.

After the exercise each participant filled out a questionnaire consisting of eight questions regarding to: study group characteristic, previous experience with virtual reality, impressions related to the presented prototype and an opinion on the general applicability of virtual reality in first aid and medical training. In three questions which were directly related to the investigated beta version of the "VR ACT" system, participants were to determine their opinion using a five-point scale (1 – very bad, 5 – very good). Statistical analysis of the data was carried out using PQStat set ver. 1.6.6.202. Quantitative variables are presented using basic descriptive statistics: the arithmetic mean (x), standard deviation (SD), minimum and maximum values and positional measures – median and quartiles (Q25− quartile I, Q75 − quartile III). Analyzes of the answers from the questionnaire were made with the Z test for one proportion. Test probability at $p < 0.05$ was considered as significant and test probability at $p < 0.01$ was considered as highly significant.

## RESULTS

The average age of 83 participants of the study was 30.8 ± 9.6 years (Me = 30, Q25 = 23, Q75 = 35). The majority of the study group consisted of paramedics, physicians and medicine students. Only 10% of respondents had previous experience with any VR device in form giving the possibility of interaction with the virtual world (Tab. 1). All participants answered three questions directly regarding the tested beta version of the "VR ACT" system. They were based on a five-point scale which is presented in Table 2. The study analyzed how many respondents specify point values of 4 and 5 (4 – good, 5 – very good). Their number was compared

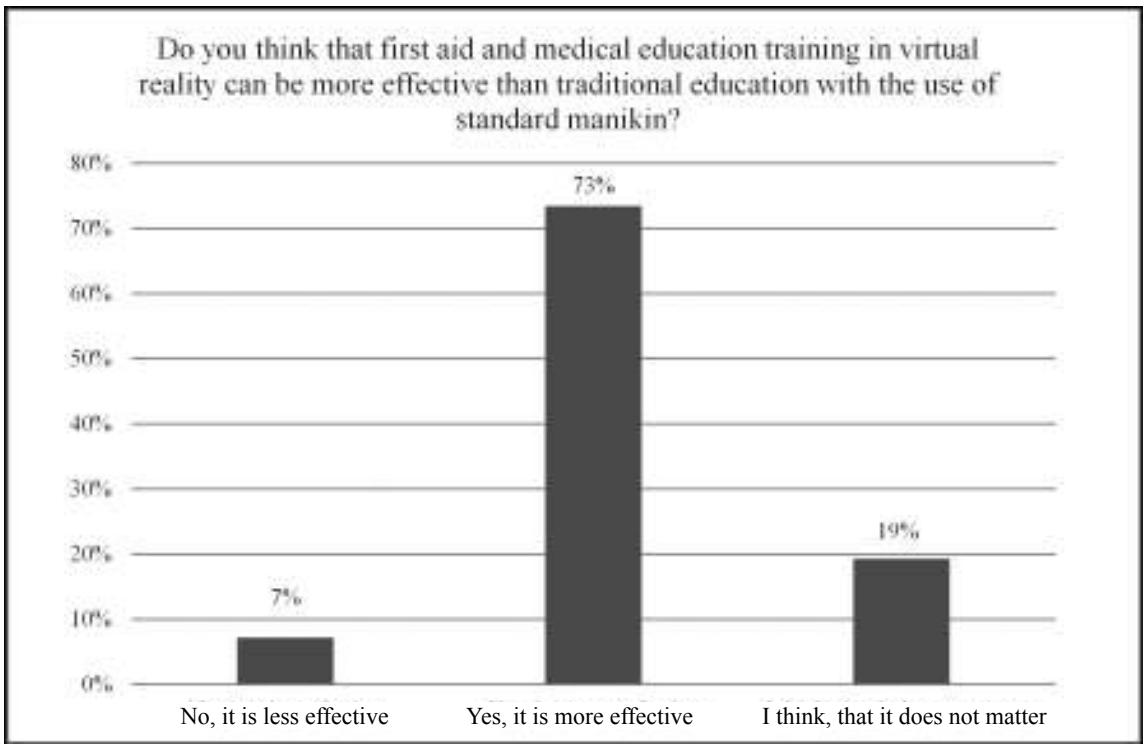


Fig. 1. Respondents' opinion on the effectiveness of first aid and medical education training in virtual reality versus training on a standard manikin.

Table 1. General characteristics of study group.

| | | n=83 | [%] |
|---|---|---|---|
| **Gender** | Male | 47 | 57 |
| | Female | 36 | 43 |
| **Profession** | Physician | 23 | 28 |
| | Paramedic | 33 | 40 |
| | Nurse | 2 | 2 |
| | Student (medical university) | 22 | 27 |
| | Other | 3 | 3 |
| **Previous experience with virtual reality** | No | 60 | 72 |
| | Yes – with the possibility of interaction with the virtual world | 15 | 18 |
| | Yes – without the possibility of interaction with the virtual world | 8 | 10 |

Table 2. Impressions of medical professionals and students, on the usefulness of software designed for CPR education in virtual reality.

| **Questions asked. How do you assess:** | | **Number of points Scale 1 – very bad; 5 – very good** | | | | |
|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 |
| the educational value of VR in first aid training and medical simulation? | n=83 | 0 | 2 | 8 | 25 | 48 |
| | % | 0 | 2 | 10 | 30 | 58 |
| the credibility of sudden cardiac arrest symptoms presented in VR ACT compared to the solutions you have known so far? | n=83 | 0 | 3 | 16 | 36 | 28 |
| | % | 0 | 4 | 19 | 43 | 34 |
| the educational value of sudden cardiac arrest symptoms presented in VR ACT (in comparison to standard training)? | n=83 | 0 | 2 | 11 | 29 | 41 |
| | % | 0 | 2 | 13 | 35 | 49 |

to the theoretical proportion of 50%. Detailed results are presented in Table 3. Sixty one respondents (73%) think that first aid and medical training in virtual reality can be more effective than traditional education with the use of standard manikin (Fig. 1). Compared to the assumed theoretical 50% ratio, the results were highly significant (95% CI 0.63-0.83; $z = 4.08$, $p < 0.01$)

## DISCUSSION

SCA is one of the leading causes of death in Europe. Depending on how SCA is defined and registered, it concerns about 55–113 per 100,000 inhabitants a year [8]. In most communities the median time from emergency call to ambulance arrival is longer than period of brain cells ability to live without perfusion and oxygen. The immediate CPR can double or quadruple survival rate chances after cardiac arrest [8]. That is why, training of lay people is a primary educational goal in resuscitation. There is also evidence that courses of basic life support (BLS) are effective in improving the number of those willing to undertake CPR in a real life. [9]. European Resuscitation Council (ERC) indicates four elements which should be crucial in BLS curriculum, regardless of the form adopted and methodology of training:

1. Recognition of unconsciousness, gasping or agonal breathing in unresponsive victims to confirm SCA;
2. A will to start CPR, including understanding of personal and environmental risks;
3. Good quality chest compressions and rescue breathing;
4. Feedback/prompts during CPR training to improve skill acquisition and retention during BLS

Table 3. Analysis of results: medical professionals and students opinion on the usefulness of of software designed for CPR education in virtual reality.

| How do you assess: | | Score 4 or 5 points | 95% CI | z value | p value |
|---|---|---|---|---|---|
| the educational value of VR in first aid training and medical simulation? | n=83 | 73 | 0,79-0,94 | 6,81 | < 0,01 |
| | % | 88 | | | |
| the credibility of sudden cardiac arrest symptoms presented in VR ACT compared to the solutions you have known so far? | n=83 | 64 | 0,68-0,86 | 4,81 | < 0,01 |
| | % | 77 | | | |
| the educational value of sudden cardiac arrest symptoms presented in VR ACT (in comparison to standard training)? | n=83 | 70 | 0,75-0,91 | 6,09 | < 0,01 |
| | % | 84 | | | |

training [9].

Probably the only way to provide a student with all these elements is high fidelity simulation (HFS). Unfortunately, it is a very expensive method. At present, the classic HFS is not always available even in the training process of medical students and personnel. The use of VR or AR can be the next milestone in CPR education. It allows to simulate different surroundings of the event site, interaction with bystanders and presentation of victims symptom (eg. SCA) without the need of building simulation rooms and using very expensive manikins. Perhaps in the future it may be a form of HFS accessible to a great part of the population. VR is already used in the form of an applications available for mobile phones [10–12]. Some research even report increased trend of bystander response (calling 911, asking for AED) after using simple VR mobile application vs. standard mobile CPR application [11]. Previously unreachable progress in BLS education can nowadays be achieved thanks to prototypes that allow to integrate cheap cpr manikin in VR space, cover it with 3-D human based model and provide hands-on training with realistic haptic feedback [13]. A recent report of Semeraro et al. [14] shows that hands-on VR training prototype "VR CPR" can also reliably measure the quality of chest compressions independently of manikin. Probably spreading this kind of CPR learning tools can make all four goals that ERC sets in BLS curriculum possible to reach. However, due to the innovative nature of the matter, it requires detailed research. Impressions of medical professionals and students on the potential usefulness of exemplar VR software in presented study are positive. The significant majority of respondents assess the educational value of "VR ACT" in first aid training and medical simulation as good or very good. Also the credibility and the educational value of the SCA symptoms presented in VR, compared to the solutions respondents had known so far, have been rated mainly for good and very good grades. Finally, statistically significant majority of respondents believe that first aid training and medical education in VR can be more effective than traditional education with the use of a standard manikin. Undeniably, the use of VR technology to create progressive CPR training model, should focus on filling gaps in SCA recognition skills and improving performance of the whole chain of survival links [15]. Perhaps after more than 10 years from the presentation of the first prototype that used VR [16] effective and innovative training of SCA recognition and management will become more real at last.

## CONCLUSIONS

Since the late eighties of the last century, medics, scientists and trainers have been trying to implement all the chain of survival links in the society as a whole. So far, no ideal training method has been developed for effective SCA recognition and providing high-quality resuscitation. Scientific reports on the use of virtual reality for this purpose are promising. However, despite the initial, positive feedback, this issue requires more detailed research.

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**Limitations of the study:**
The study was conducted in a heterogeneous group of respondents.

**Potential conflict of interest:**
Filip Jaskiewicz is medical consultant in Octopus VR, Lodz, Poland. The other authors declare no conflict of interest.

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