



Sharing is caring: a multidisciplinary first aid program

Marco Chirico*¹, Simone Bazurro¹, Andrea Calandrino^{1,2}, Manuela Chessa^{1,3},
Federica Imperiale¹, Serena Ricci^{1,3}, Alessio Riitano¹, Anna Siri⁴, Giancarlo
Torre¹

¹Simulation and Advanced Education Center, University of Genoa, Via Pastore 3, 16132, Genoa, Italy;

²IRCCS Giannina Gaslini children's Hospital, Via Gerolamo Gaslini 5, 16147, Genoa, Italy

³Department of Informatics, Bioengineering, Robotics, and Systems Engineering, University of Genoa, Via
all'Opera Pia 13, 16145, Genoa, Italy

⁴Department of Mathematics (DIMA), University of Genoa, Via Dodecaneso 35, 16146, Genoa, Italy

*Corresponding author. Email address: marco.chirico@unige.it

Abstract

Medical emergencies can occur anywhere. Children and youth are vulnerable to accidents requiring first aid assistance, despite caregivers are often untrained. An efficient way to teach first aid is through medical simulation so that trainees can familiarize with procedures in a riskless environment. Research studies showed that simulation is more effective if it takes place in a realistic environment. Within this framework, the Center of Advanced Simulation of the University of Genoa, Italy takes part in a multidisciplinary project aimed at promoting first aid awareness among students and teachers of European compulsory schools. The project which includes training activities and research lead to a mixed-reality first aid training application which combines a manikin with a virtual reality application, allowing trainees to perform lifesaving tasks in an immersive scenario. Specifically, it can be effective to learn manual and communicative skills during a first aid emergency, being also suitable for debriefing and assessment. Altogether this work aimed at defining an applicable and way to teach first aid skills, particularly focusing on European schoolteachers and students, with the ultimate goal to increase the rate of people with first aid training.

Keywords: first aid, virtual reality, medical training, emergency rescue

1. Introduction

First aid consists in the immediate assistance that an injured person should receive, in order to preserve life. In fact, first aid is often performed by a person with basic medical training while waiting for professional help. Currently, workplaces must have first aid kits, as well as first aid officers who take training courses. Despite that, the level of first aid training in Europe widely varies across countries (Heard, Pearce, & Rogers, 2020). In general, northern countries have a higher rate of trained people which ranges from 95% in

Norway, 80% in Austria and Germany, to 75% in Iceland. Conversely, in the rest of the European Union (EU) the range is as low as 5-10% of the population (IRFC health and care department, 2009).

Medical emergencies can occur anywhere; as an example, more than twelve thousand children die yearly in the United States from an unintentional injury (0.02% of all the children 0 to 19 years of age). The leading causes of injury deaths are mainly: suffocation for children less than 1 year of age; drowning (1 to 4 years of age); accidents (5 to 19 years) (Borse et al., 2008). These data suggest that children and youth are



vulnerable to injuries and accidents requiring first aid assistance, despite caregivers may not be trained. In particular, students spend a large amount of time in schools, also playing sport and extracurricular activities which may result in injuries. Therefore, teachers are often the main caregivers who need to be properly trained in first aid management, life-saving maneuvers and communication skills with both paramedics and the injured person (Mamatha, Bhat, Prakash, Sumalatha, & Ankolekar, 2020). Interestingly, research studies reported that schoolteachers are often untrained, resulting in poor and incorrect practices associated with injuries and illnesses (Dale, 1969).

Recently, Italy acknowledged that first aid training should start in primary school and for this reason, in 2017 it issued the “Guidelines for the implementation of training activities on first aid techniques” which led to the project “First aid in School” promoted by the ministry of education and the emergency system (SET 118).

1.1. State of the art

Currently, first aid training courses involve practical sessions, so that non-specialized trainees can familiarize with first aid procedures and learn by doing, which has been demonstrated being more effective than theoretical sessions (Dale, 1969). In this context, medical simulation plays an important role in the learning process, as it allows to build a background based on riskless and controlled experiences (Gaba, 2004). Indeed, First Aid training is one of the main educational thematic areas in which medical simulation is widely used and has shown great efficacy. Furthermore, recent studies have shown that in order for the simulation to be effective, the whole environment in which it takes place has to be realistic and immersive. In other words, medical simulation works better if the overall experience of the user is realistic and emotionally engaging (Fernandez et al., 2012; Peyre, Peyre, Sullivan, & Towfigh, 2006; Zeng, Woodhouse, & Brunt, 2010).

2. Materials and Methods

For all the reasons mentioned in the previous sections, the University of Genova, Italy, set up the Simulation and Advanced Education Center (SimAv), which is organized as a clinic with an operational room, patient and treatment rooms and skill labs. Simulation rooms are provided with medical equipment, hospital beds, and audio-video systems for simulation sessions recording and debriefing. Training activities take advantage of the newest and most sophisticated technologies available in the field of medical simulation, such as full-scale simulation systems including computerized full-body physiological mannequins, advanced task trainers, as well as actors playing as standard patients (role playing actors) devoted to teaching non-technical skills. At SimAv basic and advanced life support courses targets

different figures other than medical students. Particularly, basic first aid courses are delivered to family caregivers and undergraduate students, according to the Route for skills transversal and for orientation initiative of the Italian Ministry of Education, University and Research. Furthermore, an accreditation process of the Italian health ministry, allowed SimAv to organize health education courses for the Italian Academy of the Merchant Marine, teaching emergency rescue and its techniques. Two levels of training are provided: the First Aid course addressed to aspiring officers and the Medical Care course for first officers. In addition, since 2017, SimAv included the Bleeding Control program (B-Con) in all its first aid courses. B-Con is a basic medical training provided by the American College of Surgeons (ACS); it was developed in 2013 following the Hartford Consensus, and in 2017 a group of military operators of the Volunteer Military Corps of the Italian Red Cross (CMV CRI) started the delivery in Italy, mainly aimed at Police, Law Enforcement Agents and Fire-Fighters training. The B-CON course follows the guidelines provided by NAEMT and focuses mainly on threatening



Figure 1. Logo of the TIRAMISU Erasmus+ Programme KA2 – Strategic Partnership Key Action

uncontrolled hemorrhages, aiming to improve civilians ability to act as “immediate responders” in case of massive bleedings, waiting for EMS arrival (Surgeons, 2015).

Other than education, SimAv has the goal to improve training, in terms of tools and protocols. Hence, recent collaborations with university departments, association and companies are leading to:

- Research studies
- Third mission, namely knowledge transfer outside academia to the benefit of economic, social and cultural development
- Internationalization of the training activities

3. Results and Discussion

Within this framework, SimAv participates to the Tiramisu – First Aid Improve Survival Project under the Erasmus+ Programme KA2 – Strategic Partnership Key Action (Fig. 1), a new multidisciplinary project aimed at improving first aid training and increasing the rate of people who have basic first aid skills. In particular, the

project includes research studies and an educational program to promote first aid training in schools (Fig. 2).

Research in first aid has two main goals:

- assessing the efficacy of different simulation techniques (i.e. high fidelity, low-fidelity, serious games, standardized patients)
- investigating the potentialities of disruptive technologies (i.e. virtual “VR” and augmented reality “AR”, 3D printing, internet of medical skills).

The educational program instead is an international project covering all the aspects of first aid training in schools. In particular, it is aimed at increasing teachers’ skills in first aid, through simulation and active learning (Fig. 2; Fig. 3), such that they can transfer knowledge to students. Within this project, protocols, methods and techniques used in different countries for school first aid training are identified, analyzed and compared. Subsequently, considering all the pros and cons of different methods, an efficient way to teach lifesaving skills is proposed to schools across different countries. Such schools will assess it, giving feedback about their effectiveness, usability and acceptance both from instructors and students point of view.

Starting from a collaboration with the Department of Informatics, Bioengineering, Robotics and System engineering (DIBRIS), which led to a joint lab aimed at promoting multidisciplinary training, SimAv is developing research and technological development in medical simulation, throughout the cooperation of engineers, computer scientists, and physicians. In particular, the joint lab is focused on:

- implementing and testing of new prototypes
- using of innovative technologies
- studying learning processes underlying medical skills
- carrying out feasibility and efficacy studies



Figure 2. Example of a first aid training with high-school students.



Figure 3. Medical training through serious games

3.1. A mixed-reality tool for first aid training and assessment

The combination of TIRAMISU research questions and needs and the skills of the joint-lab has converged into a tool for first aid training which may quicken the learning process and improve the simulation experience. Typically, first aid practical training is performed on half body or full-body manikins (Fig. 2), so that trainees can practice on a human-like patient. However, recent studies have shown that, in order for the simulation to be effective, the whole environment in which it takes place has to be realistic and immersive. In this context, disruptive technologies such as VR and AR are intriguing tools to increase users’ engagement, immersivity and sense of presence (Slater, Linakis, Usoh, & Kooper, 1996). As VR and AR systems allows the trainee to move in the space and interact with the environment, they are currently used for surgical simulation, physiological and motor therapy, medical training (Claudio & Maddalena, 2014). Furthermore, they have been used to develop first aid training applications, showing strengths and weaknesses of such technologies (Higashi et al., 2017; Park, Kwon, Lee, Woo, & Jeong, 2013; Rodrigues, Johnson, & Weibel, 2018; Strada, Bottino, Lamberti, Mormando, & Ingrassia, 2019). In particular, AR does not provide an immersive experience, as the user often perceives virtual and real elements separately (Jennett et al., 2008). VR is more appropriate, as the brain perceives the virtual environment as it would do in the real world (Sherman & Craig, 2003). However, the difficulty of providing haptic interaction with the real environment limits its use. To overcome these constraints, we designed a first-aid training mixed-reality system combining a manikin with a VR application (Girau et al., 2019; Fig. 4).

The system includes a full-body manikin (Nursing Kelly, Laerdal, Norway; Fig. 4) combined with the VR headset *HTC Vive* (HTC, Taiwan; Fig. 4). Also, a hand tracking module *Leap Motion* (Ultraleap, USA) is used to track the user’s hand and develop interactions between the user and the environment. The VR application is

implemented using the Game Engine *Unity* (Unity Technologies, USA). Briefly, the user is physically located in a room with the real manikin and wears the headset (Head Mounted Display – HMD; Girau et al., 2019). Through the HMD, a VR scenario is displayed, and the user is immersed in a virtual urban environment, where a medical emergency occurs (Fig. 4). Specifically, a virtual replica of the mannequin overlaps the real one (Fig. 4), so that users can interact with the real manikin and their action are replicated in the VR (Fig. 4). In addition, the virtual manikin is augmented with some animations, i.e. chest and eyes movements, that changes according to the user's actions (Girau et al., 2019). With our system, learners perform first aid tasks while interacting with the simulated patient in a challenging and realistic scenario. Indeed, an interactive mixed reality learning tool may be effective to learn manual and communicative skills during a first aid emergency. In

addition, the system could log data on both the user's performance and the emergency situation (i.e. actions performed, victim vital signs) for error detection and subsequent debriefing, making the tool suitable for training and evaluation. Logging can also support the creation of a training events library of training which can maximize learning results, enhance motor skills and retention of cognitive knowledge, ultimately reducing instructor intervention and cost.

The tool we designed will be firstly assessed by first-aid experts and instructors, in order to evaluate the accuracy of the simulator; the first-aid protocols implemented; the evaluation system and the emergency scenarios. Then, we will ask unexperienced schoolteachers to try our device, comparing performance with traditional first aid training tools, both in our simulation center and in schools.



Figure 4. MR application for first aid training. Left: virtual reality representation of the manikin located in an urban environment. Right: real world, the user, through the head mounted display, sees the medical emergency on the left. With the real manikin he can physically interact with the simulated patients, while seeing a virtual representation of his own hands.

Altogether this work aimed at defining an effective way to teach first aid skills, particularly focusing on compulsory schoolteachers and students, with the ultimate goal to increase the rate of people with first aid training in Europe. Starting from the analysis of different methods currently used to teach first aid maneuvers, we designed a tool which combines traditional manual training with a VR application. We made this choice for four reasons:

1. VR can enhance the realism of the simulation experience, despite a lack of realism in the physical interaction with objects in the scene
2. a high realism degree has been reported to increase the outcome
3. gamification of a learning task can be beneficial especially for students
4. the application can be extended covering other

emergencies such as neonatal and geriatric first-aid or choking

In addition, first aid training requires manual practice repeated multiple times, under the supervision of qualified personal and dedicated equipment (e.g. manikin in the case of cardiopulmonary resuscitation techniques). Given that this project was focused on instructing teachers, usually non-medical experts, to share their first aid knowledge with students, we tried to design a system which could objectively assess learner's performance, assisting teachers during the practice.

4. Conclusions

This project aimed at improving skills and competences of compulsory schoolteachers by developing and testing at EU level an innovative transnational training course on First Aid and Health

Related Emergency practice based on simulation approach. The program will finally contribute to the horizontal priority related to supporting individuals in acquiring and developing basic skills and key competences, with specific reference to the first aid knowledge. This would make students and teachers aware that life support procedures can make the difference in society as an expression of active citizenship, a practice of solidarity, contributing to build and spread a sense of community belonging.

Funding

This work was partially supported by the program Erasmus+ KA201 Strategic Partnerships for School Education, First Aid Improve Survival and by the operative program Por FSE Regione Liguria 2014-2020 RLOF18ASSRIC/17/1

Acknowledgements

We thank Beatrice Drago, Cristiano Ferrevoux, Paolo Rossi and Fabio Vento for their support.

References

- Borse, N. N., Gilchrist, J., Dellinger, A. M., Rudd, R. A., Ballesteros, M. F., & Sleet, D. A. (2008). CDC childhood injury report: Patterns of unintentional injuries among 0-19 year olds in the United States, 2000-2006.
- Claudio, P., & Maddalena, P. (2014). Overview: Virtual reality in medicine. *Journal of Virtual Worlds Research*, 7(1).
- Dale, E. (1969). Audiovisual methods in teaching.
- Fernandez, G. L., Page, D. W., Coe, N. P., Lee, P. C., Patterson, L. A., Skylizard, L., ... Seymour, N. E. (2012). Boot cAMP: educational outcomes after 4 successive years of preparatory simulation-based training at onset of internship. *Journal of Surgical Education*, 69(2), 242-248.
- Gaba, D. M. (2004). The future vision of simulation in health care. *Quality & Safety in Health Care*, 13 Suppl 1, i2-10. https://doi.org/10.1136/qhc.13.suppl_1.i2
- Girau, E., Mura, F., Bazurro, S., Casadio, M., Chirico, M., Solari, F., & Chessa, M. (2019). A Mixed Reality system for the simulation of emergency and first-aid scenarios. *Conference Proceedings: ... Annual International Conference of the IEEE Engineering in Medicine and Biology Society. IEEE Engineering in Medicine and Biology Society. Annual Conference, 2019*, 5690-5695. <https://doi.org/10.1109/EMBC.2019.8856777>
- Heard, C. L., Pearce, J. M., & Rogers, M. B. (2020). Mapping the public first-aid training landscape: a scoping review. *Disasters*, 44(1), 205-228. <https://doi.org/10.1111/disa.12406>
- Higashi, E., Fukagawa, K., Kasimura, R., Kanamori, Y., Minazuki, A., & Hayashi, H. (2017). Development and evaluation of a corrective feedback system using augmented reality for the high-quality cardiopulmonary resuscitation training. In *2017 IEEE International Conference on Systems, Man, and Cybernetics (SMC)* (pp. 716-721). IEEE.
- IRFC health and care department. (2009). *First aid for a safer future Focus on Europe Advocacy report 2009*.
- Jennett, C., Cox, A. L., Cairns, P., Dhoparee, S., Epps, A., Tijs, T., & Walton, A. (2008). Measuring and defining the experience of immersion in games. *International Journal of Human-Computer Studies*, 66(9), 641-661.
- Mamatha, H., Bhat, N., Prakash, J., Sumalatha, S., & Ankolekar, V. (2020). Knowledge and Training of Primary School Teachers in First Aid - A Questionnaire Based Study. *The Kurume Medical Journal*. <https://doi.org/10.2739/kurumemedj.MS662001>
- Park, N., Kwon, Y., Lee, S., Woo, W., & Jeong, J. (2013). Projected AR-Based Interactive CPR Simulator. In *International Conference on Virtual, Augmented and Mixed Reality* (pp. 83-89). Springer.
- Peyre, S. E., Peyre, C. G., Sullivan, M. E., & Towfigh, S. (2006). A surgical skills elective can improve student confidence prior to internship. *Journal of Surgical Research*, 133(1), 11-15.
- Rodrigues, D. G., Johnson, J., & Weibel, N. (2018). Real-time guidance for cardiopulmonary resuscitation in Mixed Reality. In *12th EAI International Conference on Pervasive Computing Technologies for Healthcare-Demos, Posters, Doctoral Colloquium*. European Alliance for Innovation (EAI).
- Sherman, W. R., & Craig, A. B. (2003). Understanding virtual reality. *San Francisco, CA: Morgan Kaufman*.
- Slater, M., Linakis, V., Usoh, M., & Kooper, R. (1996). Immersion, presence and performance in virtual environments: An experiment with tri-dimensional chess. In *Proceedings of the ACM symposium on virtual reality software and technology* (pp. 163-172). ACM.
- Strada, F., Bottino, A., Lamberti, F., Mormando, G., & Ingrassia, P. L. (2019). Holo-BLSD-A Holographic Tool for Self-training and Self-evaluation of Emergency Response Skills. *IEEE Transactions on Emerging Topics in Computing*.
- Zeng, W., Woodhouse, J., & Brunt, L. M. (2010). Do preclinical background and clerkship experiences impact skills performance in an accelerated internship preparation course for senior medical students? *Surgery*, 148(4), 768-777.