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SERIOUS GAME, LECTURES OR SIMULATION-BASED MASTERY LEARNING COURSE WHICH IS THE BEST METHOD FOR TRAINING STUDENTS ABOUT CARDIAC ARREST MANAGEMENT?

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ABSTRACT
Background and aim: This study aimed to compare a serious game and lectures for the pretraining of medical students before learning about simulation-based management of cardiac arrest.
Methods: Participants were 150 volunteer second-year medical students between April and June 2018 randomly assigned to CPR training using either lectures (n = 75) or a serious game (n = 75). Each participant was evaluated on a scenario of cardiac arrest before and after exposure to the learning methods. The primary outcome measures were the median total training time needed for the student to reach the minimum passing score. This same outcome was also assessed three months later.
Results: The median training time necessary for students to reach the minimum passing score was similar between the two groups (p=0,45). Achieving an appropriate degree of chest compression was the most difficult requirement to fulfill for students in both groups. Singing the refrain of the song "staying alive" significantly increased the number of compressions with the correct rate. Three months later, the median training time decreased significantly in both groups. However, students have remained interested in the serious game for a longer time showing a preference for using this method.
Conclusions: The serious game was not superior to lectures to pretraining medical students in the management of a cardiac arrest.

Keywords: serious game, Cardiac Arrest

1. INTRODUCTION

Simulation training is fundamental to good learning of cardiopulmonary resuscitation (CPR) (Greif 2015; Bhanji 2015), a life-saving technique in the event of cardiac arrest, one of the leading causes of death in the world (Writing Group 2016; Berdowski 2010; Grasner 2010). The Italian Resuscitation Council (ERC) and American Heart Association (AHA) guidelines recommend the use of high-fidelity dummies, simulators, feedback devices and online training courses as resources for teaching and learning CPR (Berdowski 2010; Thorne 2015; O'Leary 2010). Since 2015, several studies have shown that the practice on dummies under the supervision of an instructor is the most effective training mode (Ericsson 2004; Wayne 2006). The training of second-year students at our university includes CPR lectures. The addition of a relevant session before the mastery learning course has been shown to reduce learning times during subsequent laparoscopic simulation training sessions (Rosenthal 2009; Stefanidis 2010) and central venous catheterization training, (Cheung 2016) as well as increasing post-test performance in CPR training (Creutzfeldt 2012; Cook 2012; Boada 2015). Serious games were used for pre-trained medical students, but only one study compared the effectiveness of recorded lessons and serious games before simulation training (Drummond 2017). Serious games promote active learning, which is associated with better learning outcomes in scientific domains, (Freeman 2014) and experiential learning when they include a 3D realistic environment close to real life (Kolb 2005).
To our knowledge, although both lectures and serious games have been used to teach health professionals before simulation training, these have never been compared. The objective of this study was to compare the effectiveness of these two modalities for second-year medical students of preparation before a CPR simulation training session.

2. MATERIALS AND METHODS

A prospective, simulation-based, randomized controlled trial was conducted in the Department of Medicine in the University of Salerno, Campus of Baronissi (Italy).
Participants were second-year medical students from the University of Salerno who volunteered between April 2, 2018, and June 10, 2018. Eligible participants were all students aged 18 or over who had never participated in CPR training. Students were invited to participate directly while attending their regular courses. Informed consent was obtained from all the individual participants included in the study. The demographic data was collected by all the participants at the entrance to the study. The participants were divided into two groups: the "only lessons" and "serious games" groups.

The study design is presented in Fig. 1. Both were developed based on the 2018 ERC Guidelines for CPR and Cardiovascular Emergency (ECC). All participants received the guidelines and followed a theoretical lecture before the training session on manikins.

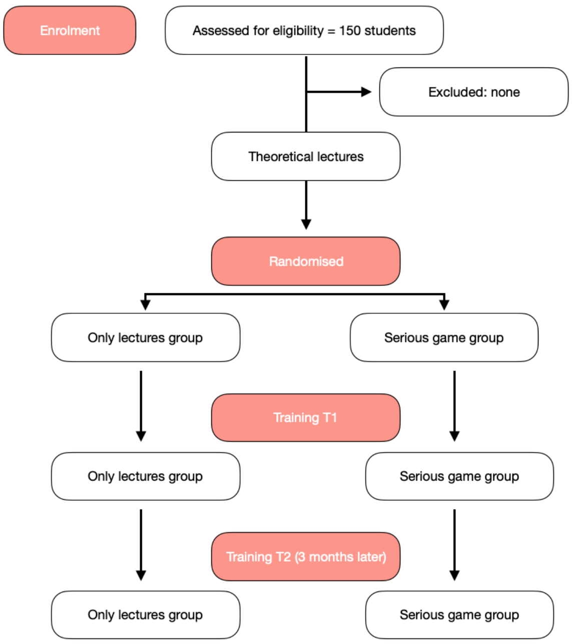

Figure 1: The study design

The serious game was designed to be a CPR self-learning tool for both healthcare professionals and lay people and simulates an urban public space where the player must identify a victim of cardiac arrest and perform CPR maneuvers to help the victim. During the game, the player must identify the victim, reach a correct cardiac arrest diagnosis, and begin CPR as soon as possible (https://youtu.be/wQsG8p3cOSI).
All the students followed a theoretical lesson given by a professor of anesthesia and resuscitation in which the ERC guidelines were illustrated with the support of a power point presentation.
After exposure to serious game and lectures, the participants were individually re-evaluated for their functional performance by five blind examiners in the group assignment who independently assessed the participants actions on a simulated 10-minute cardiac arrest scenario using a CPR training dummy (practical post-test Training T1).
During the three months of training, the participants were individually trained on cardiac arrest management using a low-fidelity dummy (ResusciAnne QCPR). The students were divided into small groups and were trained by instructors in simulation on the execution of: cardiac massage, mouth-to-mouth ventilation and with a face mask and correct use of the defibrillator. Following the principles of mastery learning, they repeated their command on the same scenario as a simulated cardiac arrest until they reached a minimum passing score (Table1)

Action	0 points	1 point	2 points
Recognizes ACC within 30 s	Incompletely or not done	Done	
Calls emergency services within 60s	Incompletely or not done	Done	
Calls for help and sends the facilitator to get AED within 60s	Incompletely or not done	Done	
Percentage of compressions with correct hands position	< 50%	50-75%	> 75%
Percentage of compressions with correct rate (100 to 120 min)	< 50%	50-75%	> 75%
Percentage of compressions with correct depth (5 to 6 cm)	< 50%	50-75%	> 75%
Flow fraction	< 50%	50-75%	> 75%
Automated external defibrillator	- not used - Incorrectly used	correctly used	

Table 1: Checklist used to determine a performance score for ACC management

A single simulated scenario of cardiac arrest was used: for the first assessment before the preliminary session, and all subsequent attempts needed to reach the minimum passing score. Medical students were asked to manage a 50-year-old patient with cardiac arrest. When the student entered the simulation room, the mannequin lay on the floor, unconscious, unresponsive to stimulation and without respiratory effort or pulse. Students had to recognize cardiac arrest, call medical emergency services, ask for help, ask for an external automated defibrillator (AED), provide chest compressions, and give a shock. A facilitator could call emergency medical services or carry an AED if requested and entered the room with the AED only when the participant performed 2 minutes of chest compressions. The scenario ended with the arrival of an emergency team immediately after the first shock or after 4 minutes if the shock was not delivered. The instructors provided a debriefing in the form of a feedback of the terminal directive after each attempt. The instructors examined with the participant all the actions performed in the light of their checklist, describing in detail the correct and incorrect responses. The participants alternated between the simulation and debriefing phases until reaching the minimum passing score. The main result was the average training time required by the students to achieve the minimum score during the practice session. The total training time for each participant, calculated using a stopwatch, corresponds to the full time dedicated to the various attempts and their debriefings. Secondary outcomes included the average student performance score that occurred immediately after pretreatment, and the median performance score assessed after three months of training. Five qualified instructors in simulation (G.S., F.O., D.B., V.M., R.S.) were involved in the evaluation of the participants' actions. Each instructor, blind to the allocation of the participants, independently assessed both the responses of the participants and the sequence of events in real time. The compression score was calculated based on the information provided by the Resusci Anne Skills software (flow fraction, hand position, speed, and depth of the compressions performed).

3. RESULTS

A total of 150 participants were included in the study and randomly assigned to the group “only lessons” (n = 75) or the “serious game” group (n = 75). All participants completed the process and were included in the data analysis. Most of the participants were women. The primary demographic characteristics were similar in the two groups (Table 2).

Characteristics	Only lessons group	Serious game group
Age,years, mean ± SD	21.6 ± 2.63	21.9 ± 2.63
Female %	59.1	65.2

Table 2: Demographic characteristics of the study population

The training time needed to reach the minimum score was similar between the two groups: 20 min in the “serious game” group (average number of attempts 3) versus 23 min in the group “only lessons” (average number of attempts 4), P = 0.51 (Fig 2).

Figure 2: Median training time and median number of attempts necessary for students to reach the minimum passing score during training 1.

Figure 3: Median training time and the median number of attempts necessary for students to reach the minimum passing score during training 2 (Three months later).

Three students in each group failed to get the minimum passing score after six attempts. These six students were unable to provide more than 50% of the compressions with the appropriate depth. Three months later, the median training time decreased significantly in both groups at 12 min in the “serious game” group and 13 min in the group “only lessons” (P = 0.78 between the groups, P <0.001 for the comparison of training 1 and 2 for both groups, Fig. 3).

Two students in the group “only lessons” that failed to reach the minimum passing score due to inappropriate compression depth failed again three months later on the other training. Achieving an appropriate compression depth was the most difficult requirement to fulfill for students in both groups and during both pieces of training (Fig.4). Among all the participants, 28% of students required more than three attempts to reach a correct compression depth.

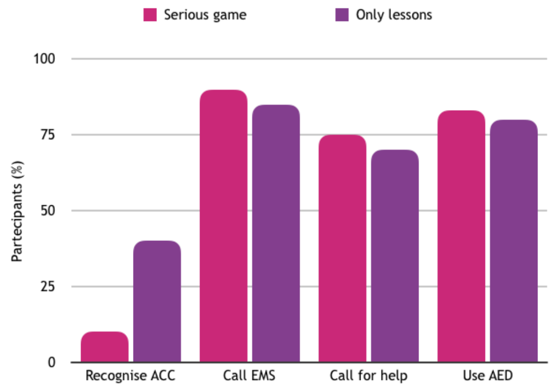

Figure 4: Percentage of participants who correctly performed each action recommended by the European Resuscitation Council guidelines after pretraining and 3 months after the training session. AED, automated external defibrillator; EMS, emergency medical services.

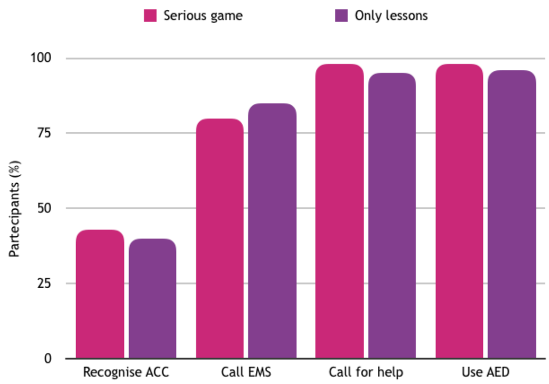

Figure 5: Percentage of participants who correctly performed each action recommended by the European Resuscitation Council guidelines three months after the training session. AED, automated external defibrillator; EMS, emergency medical services.

Finally, singing the refrain of the song "staying alive" significantly increased the number of compressions with the correct rate in both groups(p< 0.05).

4. DISCUSSION

Although a growing number of theoretical considerations that claim that serious games are more effective than lectures, our study failed to demonstrate a difference in terms of training time between the serious game and a lecture when used as pre-training tools. Our study also revealed that most of our students had difficulty reaching an appropriate depth of chest compression. The most crucial action in CPR procedures to improve patient outcome is high-quality chest compression (Dris 2015; Vadeboncoeur 2014). However, it requires practical sessions for the appropriate acquisition of skills, preferably with the use of a feedback system (Perkins 2015; Kleinman 2015). Cortegiani et al. (Cortegiani 2017), evaluating the training of secondary students on chest compressions with an instructor and a real-time electronic feedback system (Laerdal QCPR), suggested that software feedback can improve the technical acquisition on the ability to perform chest compressions with an adequate recoil compared to training with instructor-based regular feedback. The other studies that used a serious game as a supplement to CPR training found that compliance with the guidelines was slightly better for students who had been trained with a serious game (Creutzfeldt 2012; Cook 2012; Boada 2015; Alam 2016).

However, these studies did not include a group control with another mode of pre-training, nor have they involved learning the mastery of simulation.

We expected students in the serious gaming group to learn faster during the next physical simulation session than their peers who only attended the lecture because it was suggested that serious games that actively involve students in learning activities are more effective than lessons (Garris 2002). Instead, we found that both groups similarly improved their performance. The limited gameplay can explain this: the player does not have to be very busy, as mostly all that was required of the player was a simple mouse click to proceed to the next step. The only real choices made by the player were the position of the hand and the rate of chest compression. These results correspond with those of a meta-analysis, which found that simulation games were more effective than passive instructions when most of the game's instructions were active (Sitzmann 2011). Therefore, student performance in the serious game group could have been better if they had been pretreated with a more interactive serious game.

The development of serious games is more expensive and time-consuming than using methods based on lectures. In the present study, the sequence of CPR maneuvers to be performed during the gestational cardiac arrest was best recognized by the students of the "only lessons" group, although the students in the "serious game" group were more interested in the method.

The two pre-treatment modalities tested in this study, a serious game and a lecture, led to similar learning times during the subsequent practical CPR simulation training. The same level of performance achieved among students at the end of the first learning session of simulation-based mastery was not reflected in training times three months later. This suggests that some elements in the management of cardiac arrests, such as compression depth can be learned only partially by learning simulation-based mastery and supporting the use of CPR feedback devices.

5. CONCLUSIONS

Although in both groups the students improved their CPR performance scores after exposure, we cannot guarantee that, in real life situations, this performance is as effective as that of students who have received direct training as an instructor or have had access to real-time CPR feedback devices. We believe these two ways of self-learning are useful in helping students and can be used as a primary method for CPR training since they are easily accessible from a smartphone and can be integrated into face-to-face training courses for professionals in the health and also for lay rescuers.

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