Innovative training of university students in cardiac arrest in clinical Ssimulation

Entrenamiento innovador de estudiantes universitarios en parada cardíaca en simulación clínica

Nancy de los Angeles Segura-Azuara[1], Juan Carlos Hidalgo[1], Brenda Salvador[1], Elsie Vázquez Camacho[1], Santiago Martín Albo[1], Mildred Vanessa López Cabrera[1]

Abstract

Introduction: Statistics show nowadays, bystanders provided Cardiopulmonary Resuscitation (CPR) in 40-46% of all out-of-the-hospital cardiac arrests. Strategies must focus on specialized training for non-medical personnel. Engaging new generations in self-care depends on the development of new approaches to address the issue. The objective of this study was to assess the efficacy of an innovative training in CPR through the perception of the participants. **Material and methods:** This study considered a quantitative approach with a descriptive and correlational design. This study had a convenience sample of 103 participants from undergraduate programs in different disciplines: Engineering, Health, Law, and Design with participated voluntarily in the innovate training. To understand the efficacy of the innovative training data was collected of the participants through a self-assessment rubric. While participants were taken part in the training, an expert assessor was observing the performance and scored the procedure using a similar rubric. Both rubrics use a 5-point Likert scale to assess the level of agreement with each sentence. **Results:** Self-assessment results show that students excel on identifying if a patient has a pulse (mean=4.47) and if a patient is breathing (mean=4.52). The results of the expert assessment indicate a higher level of performance in hand positioning (mean=4.75) and compression-ventilation coordination (mean=4.77).

Discussion: These results are encouraging as participants gained confidence on basic procedures, the main challenges are still on skills that rely deeply on practice. Therefore, this training might need to be offered periodically, as any certification offered for health professionals. This study is a first attempt to design an innovative short term and effective training that universities can replicate to prepare their students for these life-saving skills.

Keywords: CPR; educational innovation; clinical simulation; non-health personnel.

Resumen

Introducción: Las estadísticas muestran que hoy en día los transeúntes realizan la reanimación cardiopulmonar (RCP) en el 40-46% de las paradas cardíacas extrahospitalarias. Las estrategias deben centrarse en la formación especializada del personal no médico, por lo que es importante desarrollar; nuevos enfoques para abordar el tema y comprometer a las generaciones más jóvenes en el autocuidado. El objetivo de este estudio fue evaluar la eficacia de un entrenamiento innovador en RCP a través de la percepción de los participantes. **Material y métodos:** Se utilizó un diseño cuantitativo para correlacionar ambas medidas de rendimiento. Este estudio consideró un enfoque cuantitativo con un diseño descriptivo y correlacional. Este estudio tuvo una muestra de conveniencia de 103 participantes de programas de pregrado en diferentes disciplinas: Ingeniería, Salud, Derecho y Diseño con participación voluntaria en el entrenamiento innovador. Para entender la eficacia de la formación innovadora se recogieron datos de los participantes a través de una rúbrica de autoevaluación. Mientras los participantes participaban en la formación, un evaluador experto observaba la actuación y puntuaba el procedimiento utilizando una rúbrica similar. Ambas rúbricas utilizan una escala Likert de 5 puntos para evaluar el nivel de acuerdo con cada frase. **Resultados:** Los resultados de la autoevaluación muestran que los estudiantes destacan en la identificación de si un paciente tiene pulso (media=4,47) y si un paciente respira (media=4,52). Los resultados de la evaluación de expertos indican un mayor nivel de rendimiento en la colocación de las manos (media=4,75) y en la coordinación compresión-ventilación (media=4,77). **Discusión:** Estos resultados son alentadores, ya que los participantes ganaron confianza en los procedimientos básicos; los principales retos siguen siendo las habilidades que dependen en gran medida de la práctica. Por lo tanto, es posible que esta formación deba ofrecerse periódicamente, como cualquier certificación

---

(1) Tecnológico de Monterrey, Escuela de Medicina y Ciencias de la Salud Monterrey. Nuevo León, México.
Autor de correspondencia: nsegura@tec.mx

ofrecida a los profesionales de la salud. Este estudio es un primer intento de diseñar una formación innovadora, eficaz y de corta duración, que las universidades pueden replicar para preparar a sus estudiantes en estas habilidades que salvan vidas.

Introduction

Worldwide, cardiac arrest is a significant health problem estimated to cause 15-20% of all deaths (Böttiger *et al.*, 2018). According to the American Heart Association, cardiac arrest is between 250,000 and 425,000 cases yearly from 2012 to 2016 in the US alone. In Europe, more than 700,000 people die from cardiac arrest (SCA Foundation, 2018). In the US, around 40-46% of out-of-the-hospital cardiac arrests (OHCA) received CPR by a bystander, with a survival rate of 9.5-12% (Wissenberg *et al.,* 2013). In other countries, bystander resuscitation rates reach levels above 60%, and 15 to 20% of out-of-the-hospital cardiac arrests end with hospital treatment SCA Foundation, 2018).

One of the main factors related to survival is that it usually takes too long for the emergency medical service (EMS) to arrive at the scene after the victim collapses (Böttiger *et al.*, 2018). The time the victim is pulseless is related to survival; even after 3-5 minutes of circulatory arrest, neurons start to die. Data about resuscitation rates are contradictory, with estimates ranging from 5 to 80% across the world; bystander immediate hands-on response is crucial for survival (Wissenberg *et al.,* 2013). Several initiatives to increase bystander training in CPR included both in children and adults, such as "Kids Save Lifes" and "All citizens of the world can save a life" that have been effective in training individuals (Bohn *et al.*, 2015).

Definition and algorithm

Cardiac arrest is the abrupt loss of heart function, it can come on suddenly or in the wake of other symptoms (Ramireddy & Chugh, 2021). Pulse and blood pressure are lost instantaneously, followed by a loss of consciousness in a matter of seconds (Panhuyzen-Goedkoop *et al.*, 2018). Not following the appropriate steps in the algorithm can result in death. In cardiac arrest, the likelihood of surviving declines by approximately 10% for every minute that it takes to start maneuvers; and can progress to irreversible biological death within 10 minutes (Eisenberg, 2013).

CPR and immediate use of a defibrillator may reverse cardiac arrest and restore normal heart rhythm. Up to 30% of normal blood flow can be achieved with good quality CPR, thus maintaining a small blood flow to the vital organs, particularly the heart and brain, which are the most sensitive to the lack of oxygen (Kornegay *et al.*, 2018). CPR can allow the cardiac muscle to contract and restore a normal heart rhythm, which reduces the possibility of brain damage (Marino *et al.*, 2018).

It is important to emphasize that CPR by itself gains time. On the other hand, defibrillation is curative; by simultaneously depolarizing all heart fibers, it allows the inherent pacemaker capacity of the heart to re-establish its rhythm. The sooner both CPR and defibrillation start, the better the outcome. We know that bystander CPR will double the survival rate and that early use of an automated external defibrillator can increase survival rates up to 75% in witnessed cardiac arrests (Alshahari *et al., 2018)*.

Training for CPR

Research shows that the better bystanders can identify a cardiac arrest and perform the correct sequence in the procedure, the higher the success rate, leading to appropriate care for compromised patients. Learning a life-saving technique like CPR is no longer limited to health-related professionals (Alsharari *et al.,* 2018). Bystanders usually have narrowed their participation in the event of cardiac arrest because they do not feel prepared to deal with the situation; therefore, formal training could benefit their inclusion (Al-Shaqsi *et al.*, 2018). Training laypeople on using an AED during OHCA leads to increased survival (Callahan & Fuchs, 2018).

Some high schools and universities have declared mandatory learning on how to perform CPR for their students. More than 30 states in the US have CPR training requisite for high school graduation (Callahan & Fuchs, 2018). Alsharari *et al.* (2018) suggest that a 3-week course is effective in the final year of university, and as a result, it started to be a graduation requirement. Others advocate that training must be frequent to incorporate the new improvements in the clinical guidelines and agree that this type should be yearly for health-related colleges (Alsayil *et al.*, 2016).

Incorporation of simulation for training

Although all training in CPR may represent an improvement in skills' assessments, the educational trends have suggested a shift towards active learning techniques, declaring the need to perform

simulated scenarios to prepare participants to deal with the emotions and stress of life-threatening situations. Research has shown that demonstrating those procedures and receiving expert feedback is vital for skills improvement. Some studies have used self-assessment to measure performance in the correct technique, but they lack the opportunity to assess the procedures and maneuvers' sequence. Although some authors argue that self-assessment is of little value since there is frequently low consistency with the observed performance by experts, it has two main benefits (Davis *et al.*, 2006). One, it consolidates learning by helping students to reflect on what they have learned in the light of previous experiences allowing the development of expertise and students' engagement in their learning as they start applying these assessment criteria consistently; and two, it helps in building on confidence about performance in real-life situations.

Using simulation for training has several advantages, including solving scheduling issues and appropriate case selection while avoiding risks in patient safety. Mundell (2013) argues that simulation-based scenarios benefit resuscitation training. The authors claim that this training is more effective than traditional approaches without simulation interventions for acquiring procedural skills. However, this does not have an impact on knowledge-based or speed-based assessment.

The objective of this study was to assess the efficacy of an innovative training in CPR through the perception of the participants.

Material and methods

This study considered a quantitative approach with a descriptive and correlational design for the analysis.

This study considered a convenience sample of 103 participants from undergraduate programs in different disciplines: Engineering, Health, Law, and Design with participated voluntarily in the innovate training.

To understand the efficacy of the innovative training data was collected of the participants through a self-assessment rubric. The self-assessment rubric evaluates the previous knowledge of the participant regarding CPR, out-of-hospital chain of survival, and use of AED. While participants were taken part in the training, an expert assessor was observing the performance and scored the

procedure using a similar rubric. This rubric describes activating an emergency response system, appropriate placement of hands and arms for compressions, opening the airway, and starting proper ventilation. Both rubrics use a 5-point Likert scale to assess the level of agreement with each sentence proposed, where 1 stands for total disagreement and 5 for total agreement.

For the analysis, descriptive statistics were used to understand trends in every item. Afterward, the expert assessor score was contrasted with the self-assessment using Pearson correlation. The ranges used for the interpretation of the correlation were: weak (interval 0 to 0.25), low (0.26 to 0.50), high (0.51 to 0.75), and strong (0.76 to 1). The last part of the analysis focused on assessing the educative impact of the program, therefore an assessment of the quality of CPR was conducted. This assessment focused in the participant achieving a chest compression depth > 5cm, chest compression rate 100-120/min, pre-shock pause > 10 sec, and chest compression fraction > 60%.

As part of this innovative training for university students in cardiac arrest using clinical simulation, participants received a 4-hour workshop based on the guidelines on the American Heart Association (AHA) on basic CPR. The first part of the workshop consisted of a lecture to raise awareness of bystander engagement in medical emergencies and the technical aspects of CPR. After that, each student started practicing on an instrumented, auditory, and visual feedback on rate and depth of compression mannequin while on a clinical simulation scenario from the AHA manuals about an adult cardiopulmonary arrest. Later, they formed teams of four to practice CPR performed by1 and 2 rescuers. This training consisted of basic life support (BLS) for lay rescuers: Assessment, EMS activation, the ABCs for CPR, and defibrillation. They were then assessed by a medical expert in the current AHA guidelines on BLS for lay rescuers, using the procedural assessment rubric. The expert provided feedback on performance to the student.

Results

The sample consisted of 49% female and 51% male participants. Self-assessment results show that students excel on: identifying if a patient has a pulse (mean of 4.47) and if a patient is breathing (mean of 4.52).

Table 1: Self-assessment of participants.

Criterion	Item	Mean	Standard deviation
Preparation procedures	The participant assesses scene safety (self-safety and patient safety).	3.98	0.64
	The participant identifies the level of consciousness.	4.34	0.62
	Activates Emergency Medical Services (EMS)	4.16	0.73
	Total:	4.16	0.66
Cardiac compressions	The participant places both hands on the sternal bone, one on top of the other.	4.75	0.47
	The participant keeps his/her arms in a straight position to start compressions.	4.63	0.54
	The participant starts compressions promptly.	4.67	0.5
	Total:	4.68	0.50
Coordination with ventilation	The participant starts ventilation.	3.93	0.67
	The participant coordinates compressions and ventilation adequately.	4.77	0.42
	Total:	4.35	0.545
Pulse	The participant assesses pulse (determines if it is absent).	4.67	0.47
Airway and breathing	The participant opens the airway and removes obstruction if visible.	3.98	0.61
AED Defibrillator	The participant installs the AED correctly on the patient upon arrival.	4.65	0.47
	The participant follows the AED instructions adequately.	4.63	0.48
	Total:	4.64	0.475
After CPR	The participant re-starts compressions.	4.24	0.76
	The participant re-starts ventilation.	3.82	0.82
	Total:	4.03	0.79

The results of expert competence assessment indicate a higher level of performance in hand positioning and compression-ventilation coordination.

Table 2: Experts' procedural assessment of participants.

Criterion	Item	Mean	Standard deviation
Preparation procedures	The participant assesses scene safety (self-safety and patient safety).	3.98	0.64
	The participant identifies the level of consciousness.	4.34	0.62
	The participant activates Emergency Medical Services (EMS)	4.16	0.73
	Total:	4.16	0.66
Cardiac compressions	The participant places both hands on the sternal bone, one on top of the other.	4.75	0.47
	The participant keeps their arms straight to start compressions.	4.63	0.54
	The participant starts compressions promptly.	4.67	0.50
	Total:	4.68	0.50
Coordination with ventilation	The participant starts ventilation.	3.93	0.67
	The participant coordinates compressions and ventilation adequately.	4.77	0.42
	Total:	4.35	0.55
Pulse	The participant assesses pulse (determines if it is absent).	4.67	0.47
Airway and breathing	The participant opens the airway and removes obstruction if visible.	3.98	0.61
AED Defibrillator	The participant installs the AED correctly on the patient upon arrival.	4.65	0.47
	The participant follows the AED instructions.	4.63	0.48
	Total:	4.64	0.47
After CPR	The participant re-starts compressions.	4.24	0.76
	The participant re-starts ventilation.	3.82	0.82
	Total:	4.03	0.79

A correlation between self-assessment and expert performance assessment showed a weak correlation on the following elements:

pulse and airway and breathing (Table 3).

Table 3: Comparison between self-assessment and experts' assessments.

Criterion	Self- assessment	Expert	Correlation
Preparation procedures	-	4.16	-
Cardiac compressions	4.19	4.68	-0.02
Coordination with ventilation	4.05	4.35	0.05
Pulse	4.47	4.67	0.22
Airway and breathing	4.52	3.98	-0.2
AED Defibrillator	4.37	4.64	-0.16
After CPR	4.04	4.03	-0.04

To assess the educative impact of the program, a quality assessment of CPR was conducted. This analysis shows overall high scores (table 4); with the highest achievement in reasonable compression rate, pre-shock pause, chest compression depth, and chest compression fraction were in descending order.

Table 4: Analysis of CPR Quality.

Criterion	Accuracy %	Standard deviation
Chest compression depth $\geq$ 5cm	93.2	0.43
Chest compression rate 100-120/min	96.2	0.44
Pre-shock pause $\geq$ 10 sec	94.4	0.66
Chest compression fraction > 60%	92.6	0.42

Discussion

From the results obtained from self-assessment, we can extract that the participants perceive that they know the theoretical CPR procedure; since they remember the steps before using a defibrillator and the appropriate hand placement before starting compressions and ventilation. Nevertheless, they seem unsure about performing cardiac compressions and placing the victim in the recovery position. Some authors have proposed that self-assessment is inaccurate, while others advocate for its use, with good results (Anderson *et al.*, 2017; Weston *et al.*, 2018). According to the expert's assessment, the participants were proficient in hand placement and the compression procedure. However, they were not able to perceive when to start and re-start compressions and ventilation. Although this would depend on the specific context they would be required to perform; participants would benefit from using clinical simulation to experience multiple similar cases and feel self-confident.

The weak correlation we found between self and expert's assessment in this study is consistent with other researchers (Davis *et al.*, 2006). Repetition of the training practice results in reducing the gap in scores as students evolve from novice to expert. In this research, experts found a higher level of performance than that perceived by students, which points to students' high level of exigence compared to experts' assessment. Providing multiple feedback sessions for each practice session could help students build confidence for their performance in real-life settings. Still, CPR quality analysis results showed high scores, demonstrating the technique's effectiveness in this population.

As any intervention, this study has several limitations. The first one has to do with the sample considered as only participants from a single institution and one country participated in the study. Therefore, results might not be representative of other populations. The participants were undergraduate students then the success of this strategy might be limited to a youth and young adult population, and the application of the intervention in other communities may be approached with caution. As part of the analysis, we did not consider an assessment before the intervention, so we could not contrast performance categorizing prior knowledge on CPR. Future studies might approach the need to understand the effect of formal trainings or informal approaches such as movies or tv shows in the preparation of lay personnel.

Conclusion

With statistics showing that 40-46% of out-of-the-hospital cardiac arrests received CPR by a bystander, there is a critical need to implement strategies for training everyone. Training non-medical personnel in CPR techniques is beneficial to face the cardiac arrest health problem worldwide. These results are encouraging as the participants gained confidence on basic procedures, the main challenges are in identifying the moment to start or finish the compressions; however, these skills rely deeply on practice. Therefore, this training might need to be offered periodically, as any certification offered for health professionals. This study is a first attempt to design an innovative short term and effective training that universities can replicate to prepare their students for these life-saving skills. Several techniques could improve the appropriation of the algorithms and procedures of CPR, analyzing the effectiveness of this innovative training for university-level students could improve the quality of teaching methods to target specific groups using clinical simulation.

Sources of financing

None.

Contributions and conflicts declared by the authors

NASA: conceptualization, methodology, analysis, project management, review, and editing of the final manuscript.
JCH: field research, analysis, writing of the first manuscript.
BS: field research, analysis, writing of the first manuscript.
EV: field research, analysis, writing of the first manuscript.
SA: field research, analysis, writing of the first manuscript.
ML: field research, analysis, project management, review, and editing of the final manuscript.
The authors declare that they have no conflicts of interest.

References

Alsayil SN, Alzahran SM. & Alhawiti WM. (2016). Awareness of basic life support among medical and nursing students at Tabuk University. *Basic Research Journal of Medicine and Clinical Sciences* **5**, 53-57.

Al-Shaqsi S, Al-Risi A. & Al-Kashmiri A. (2018). Do laypeople in Oman know how to perform cardiopulmonary resuscitation? *Oman Medical Journal* **33,** 178-179.

Alsharari AO, Alduraywish A, Al-Zarea EA, Salmon NI. & Sheikh MSA. (2018). Current status of knowledge about cardiopulmonary resuscitation among university students in the Northern region of Saudi Arabia. *Cardiology Research and Practice* **2018**,1-9.

Andersson D, Rankin A. & Diptee D. (2017). Approaches to team performance assessment: a comparison of self-assessment reports and behavioral observer scales. *Cogn Technol Work* **19**, 517–528.

Bohn A, Lukas, R, Breckwoldt J, Böttiger BW. & Van Aken H. (2015). Kids save lives: why schoolchildren should train in cardiopulmonary resuscitation. *Curr Opin Crit Care* **21**, 220-225.

Böttiger BW, Lockey A, Aickin R, Castren M, de Caen A, Escalante R, Kern KB, Lim SH, Nadkarni V, Neumar RW, Nolan JP, Stanton D, Wang TL. & Perkins GD. (2018). "All citizens of the world can save a life" - The World Restart a Heart (WRAH) initiative started in 2018. *Resuscitation* **128**, 188-190.

Callahan JM. & Fuchs SM. (2018). Advocating for life support training of children, parents, caregivers, school personnel, and the public. *Pediatrics* **141**.

Davis DA, Mazmanian PE, Fordis M, Van Harrison R, Thorpe KE. & Perrier L. (2006). Accuracy of Physician Self-assessment Compared With Observed Measures of Competence. *JAMA* **296**,1094-1102.

Eisenberg MS. (2013). Resuscitate!: how your community can improve survival from sudden cardiac arrest. University of Washington Press. Kornegay JG, Von Foerster N, Laurie A, & Daya M. (2018). Does Accelerometer Use Lead to Higher Quality CPR for Advanced Cardiac Life Support Providers? A Prospective Randomized Study. *Eurasian Journal of Emergency Medicine* **17**, 153.

Marino BS, Tabbutt S, MacLaren G, Hazinski MF, Adatia I, Atkins DL, Checchia P, DeCaen A, Fink EL, Hoffman GM, Jefferies JL, Kleinman M, Krawczesky CD, Licht DJ, Macrae D, Ravishankar C, Samson RA, Thiagarajan RR, Toms R, Tweddell J. & Laussen PC. (2018). Cardiopulmonary resuscitation in infants and children with cardiac disease: a scientific statement from the American Heart Association. *Circulation* **137**, e691-e782.

Mundell WC, Kennedy CC, Szostek JH, & Cook DA. (2013). Simulation technology for resuscitation training: A systematic review and meta-analysis. *Resuscitation* **84**, 1174–1183.

Panhuyzen-Goedkoop NM, Wellens HJ. & Piek JJ. (2018). Early recognition of sudden cardiac arrest in athletes during sports activity. *Neth Heart J* **26**, 21–25.

Ramireddy A. & Chugh SS. (2021). Do peak times exist for sudden cardiac arrest. *Trends in Cardiovascular Medicine* **31**, 172-176.

SCA Foundation. (2018). AHA releases the latest statistics on sudden cardiac arrest | Sudden Cardiac Arrest Foundation. Available at. Accedido en: http://www.sca-aware.org/sca-news/aha-releases-latest-statistics-on-sudden-cardiac-arrest el 8 de octubre de 2018.

Weston BW, Jasti J, Mena M, Unteriner J, Tillotson K, Yin Z, Colella R. & Aufderheide TP. (2019). Self-Assessment Feedback Form Improves Quality of Out-of-Hospital CPR. *Prehospital Emergency Care* **23**, 66–73.

Wissenberg M, Lippert FK, Folke F, Weeke P, Hansen CM, Christensen EF, Jans H, Hansen PA, Lang-Jensen T, Olesen JB, Lindhardsen J, Fosbol EL, Nielsen SL, Gislason GH, Kober L & Torp-Pedersen C. (2013). Association of national initiatives to improve cardiac arrest management with rates of bystander intervention and patient survival after out-of-hospital cardiac arrest. *JAMA* **310**,1377-1384.