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ORIGINAL ARTICLE

First Evaluation of the Brazilian Advanced Life Support Training (TECA A)

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Abstract

Background: Cardiac arrest (CA) is a common condition associated with high mortality. The Brazilian advanced life support training TECA A (*Treinamento em Emergências Cardiovasculares Avançado — Advanced Cardiovascular Emergency Training*) was created to train healthcare professionals in the management of CA. However, there are no studies evaluating the effectiveness of TECA A.

Objective: To assess the impact of TECA A on the management of CA using a simulated CA situation.

Methods: Fifty-six students underwent a simulated case of CA in a manikin. The students' performance in the management of CA was assessed for the time to first chest compression and defibrillation and for a global assessment score using a structured tool. These items were assessed and compared before and after the TECA A. Exclusion criteria were previous participation in CA trainings and absence from class. Categorical variables were compared using the McNemar test and quantitative variables using the Wilcoxon test. All tests were two-tailed, and statistical significance was set at $p < 0.05$.

Results: Compared with before TECA A, median global assessment scores were higher after TECA A (pre-training: 4.0 points [2.0-5.0] vs. 10 points [9.0-10.0]; $p<0.001$), the time to start chest compressions was shorter (pre-training: 25 seconds [15-34] vs. 19 seconds [16.2-23.0]; $p=0.002$) and so was the time to defibrillation (pre-training: 82.5 seconds [65.0-108.0] vs. 48 seconds [39.0-53.0]; $p<0.001$).

Conclusions: The TECA A promoted a higher adherence to cardiopulmonary resuscitation (CPR) guidelines and a reduction in the time elapsed from CA to first chest compression and defibrillation.

Keywords: Heart Arrest; Teaching; Health Personnel; Simulation Training.

Introduction

Cardiac arrest (CA) has an incidence of 14.9-147.8 cases per 100,000 inhabitants.[1] In Brazil, it is estimated 200,000 cases per year, half of them in hospital settings.[2] Hospital discharge rates after CA varies according to the proportion of shockable rhythms and geographical location.[1] A Brazilian study with patients who had an out-of-hospital CA and were resuscitated by emergency ambulance staff reported a hospital discharge rate of 3.9%.[3]

The prevalence and poor prognosis of CA make clear the importance of the adequate training of healthcare professionals involved in its management. One of the most offered courses in CA in Brazil is the American Heart Association (AHA)'s Advanced Cardiovascular Life Support (ACLS). Aiming to include regional needs in the advanced life support training, the Brazilian Society of Cardiology (SBC) launched the TECA A (*Treinamento em Emergências Cardiovasculares Avançado — Advanced Cardiovascular Emergency Training*). The course uses simulation methods not only for the management of CA

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Central Illustration: **First Evaluation of the Brazilian Advanced Life Support Training (TECA A)**

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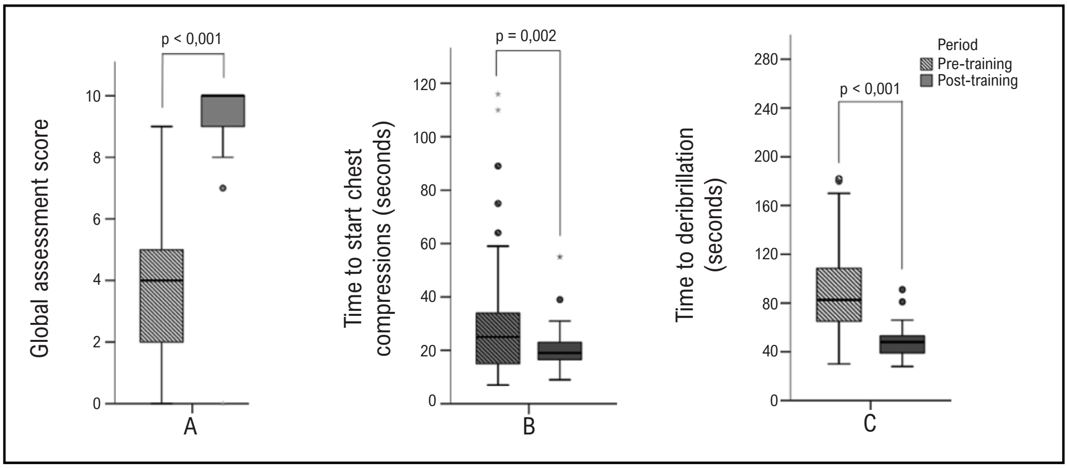

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Students' performance before and after TECA A: (A) global assessment score; (B) time to start chest compressions; (C) time to defibrillation

but also of acute coronary syndrome (ACS), acute heart failure (AHF), cerebrovascular accident (CVA), and some arrhythmias. TECA A was assessed and is recommended by the National Commission on Medical Residency,[4] and is renowned by health care accreditation organizations like the Joint Commission and the Brazilian National Accreditation Organization. However, after a review of the literature, we did not find any studies objectively evaluating the students' outcomes following the course. In order to support the recommendation of the TECA A, to understand its cost-benefit relationship, and even to estimate potential benefits to patient survival, it is crucial to investigate the impact of this course on acquisition of knowledge and skills by the trainees.

The aim of the present study was to compare the performance of students in a simulated CA situation before and after taking the TECA A, in terms of the time elapsed from the event to first chest compression and defibrillation, and a global assessment score.

Methods

Study population and design

This was an open, cross-sectional study conducted between 23 May 2015 and 28 February 2017. The study was approved by the ethics committee of Unifesp (approval number 1.113.016). The sample was determined by convenience sampling method, including the first consecutive students that agreed to participate in the study until the available number of enrollments was reached. The post hoc sample size calculation, considering an α of 0.05, power (1-β) of 0.8, and the effect size calculated from results of the pilot study showed that 23 individuals would be needed. The post hoc statistical power analysis was made by the computed achieved power[5] post hoc test, assuming an α of 0.05 and the effect size calculated from sample data.

The inclusion criteria were students attending the final year of medical school who could participate in the two-day practical training. Exclusion criteria were previous participation in advanced life support courses, discussion of simulated cases or training assessments, and absence from classes. All participants signed an informed consent form.

Performance assessment

The metrics used in the assessment of students' performance were the time between the beginning of cardiopulmonary resuscitation (CPR) and first defibrillation, and the score assigned in a global assessment tool constructed for this protocol. This was composed of 10 items based on similar criteria adopted by the AHA to award students an ACLS certificate. This certificate was previously validated as it was shown to be associated with increased rates of return of spontaneous circulation and hospital discharge of CA patients.[6] The score ranged from 0 to 10, with one point assigned for each item completed.

In addition, two mandatory actions had to be completed, otherwise all other questions would be considered invalid, and the student would receive a “zero” grade. The items of the global assessment of students’ performance were: 1. Ask a helper to get a defibrillator before checking the pulse; 2. Begin CPR immediately (within five seconds) after identifying absence of pulse; 3. Right after the defibrillator is brought, check the rhythm; 4. Restart resuscitation immediately (within five seconds) after the shock; 5. Continue CPR for two minutes without interruption; 6. Check cardiac rhythm of asystole by verifying cables, increasing the gain and changing the lead; 7. Evaluate potential causes of CA ; 8. Pulse check when the rhythm is organized rhythm; 9. Refer for endotracheal intubation and monitor vital signs; 10. Order an electrocardiogram. The two mandatory actions were: 1. To perform CPR in a pulseless patient; 2. To perform defibrillation in a patient with ventricular fibrillation (VF).

Global assessment of students’ performance and registration of times were conducted in person by an observer before and after the training. The care provided by a group of students was video-recorded and their performance was assessed by an observer who was blinded to the training and the evaluation time (pre/post training). This procedure aimed to validate the data recorded by the observer in person.

Procedures

All students completed the TECA A. The students were divided into groups of up to eight students and the classes were taught by teachers certified by the SBC. The training was conducted in person and had a duration of 16 hours. Each participant had previously received a handbook for preparation on cardiovascular emergencies, which were classified into three time points: pre-CA, during CA, and post-CA. The handbook had 146 pages and 13 chapters: 1. Introduction; 2. Chain of survival; 3. Basic life support for adults; 4. Prognostic factors; 5. Practical skills; 6. Advanced life support; 7. Post-CA care; 8. Rapid response systems; 9. ACS; 10. Bradyarrhythmias; 11. Tachyarrhythmias; 12. CVA; 13. AHF. The students received an email about the need to study the handbook in advance and had online access to supporting texts and training to identify cardiac rhythms on the electrocardiogram. The course began with a basic life support training, with a manual defibrillator and invasive and non-invasive airway procedures. Subsequently, the students passed through a series of practical stations with simulated clinical cases, and 50-minute trainings on AHF, ACS, CVA, arrhythmias, CA and post-CA care.

Before the training, each student performed a simulated CA using a manikin, and were instructed to perform actions as in real life. A clinical case was proposed with the following instruction: “You are at the emergency department and were asked to care for an unconscious patient. You may start now”. At this time, the stopwatch was started to measure the amount of time elapsed until the first chest compressions and defibrillation. In this simulated case, the patient had a CA with VF. After the first defibrillation, the cardiac monitoring device connected to the manikin showed a straight line until the student found out possible causes of the CA. Then, the monitor showed an organized rhythm until the interventions were concluded, which was determined by the student. The student should not receive any help from the examiner during the simulation. After the course, the student was asked to perform the same manikin simulation that was proposed before TECA A.

Global assessment of students’ performance and registration of the time to first chest compression and defibrillation were made in person by an observer who was unblinded to the assessment and to the training. The simulation was also video recorded and evaluated by a blinded observer.

Statistical analysis

A database was created using the Microsoft Excel (15.29) software using data collected from the checklist of the global assessment of the students’ performance. The percentage of students who performed chest compressions, the time elapsed between the beginning of treatment and beginning of chest compressions, and between the beginning of treatment and defibrillation before and after the training were compared. Categorical variables were expressed as absolute and relative frequency and compared using the McNemar test. Normality and homoscedasticity of continuous variables were analyzed using the Shapiro and the Leven tests, respectively. The global assessment score, the time to first chest compression and the time to defibrillation did not meet the normality assumption even after data transformation. Then, comparison of these parameters was made using the non-parametric Wilcoxon test, and results were expressed as median and interquartile range (25-75%). Associations of the score and the time registered by the blinded observer with the ones registered by the observer in person were analyzed using the Spearman correlation coefficient;[7] the comparison of these data was made using the Mann-Whitney, and data were expressed as median an interquartile range (25-75%).[7]

Sample size and post hoc power calculation was performed using the GPower software, version 3.1, and the other analyses using the R software (R Development Core Team, 2019).[8] All tests were two-tailed, and statistical significance was set at $p < 0.05$.

Results

Study sample and students' performance

The sample was composed of 56 students, 33 (58.4%) of them male, and mean age of 26.4 years. Individual scores in the global assessment of the simulated CA situations before and after TECA A are shown in Figure 1.

Median global assessment scores were higher, and the median time to begin chest compressions and the median time to defibrillation were lower after TECA A compared with before (Table 1). Post-hoc statistical power was calculated for 100% to score differences, 93% of the time to begin compressions and 99% of the time to defibrillation. There was no statistically significant difference (p = 0.121) in the percentage of students that performed chest compressions before (91.1%) and after (98.2%) TECA A, or in the percentage of students who performed defibrillation (92.9% *versus* 100%, respectively; p = 0,130).

After TECA A, there was a reduction in the interquartile range for the global assessment score (Central Illustration A), time to start chest compressions (Central Illustration B) and time to defibrillation (Central Illustration C).

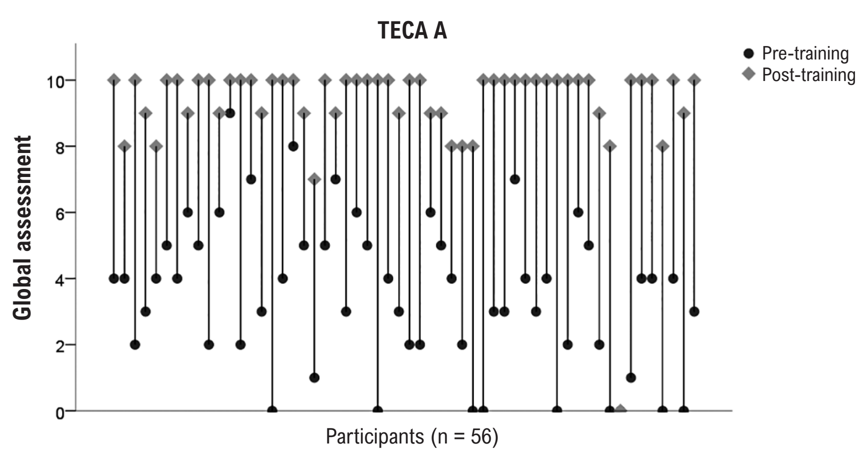

Figure 1 – Global assessment scores of each participant before and after the practical training (TECA A)

Table 1 – Students' performance before and after the TECA A course

	TECA A (n = 56)		
	Pre-training	**Post-training**	**p-value**
Scores Median (25%-75%)	4.00 (2.00-5.00)	10.00 (9.00-10.00)	<0.001
Time to first compression (seconds) Median (25%-75%)	25.0 (15.0-34.0)	19.0 (16.25-23.0)	0.002
Time to defibrillation (seconds) Median (25%-75%)	82.5 (65.0-108.0)	48.00 (39.00-53.00)	<0.001

Continuous variables were analyzed by the Wilcoxon test and expressed as median an interquartile range (25-75%)

Interobserver evaluation

There was no difference in the scores, time to first compression or time to defibrillation recorded by the two observers (Table 2). Due to technical limitations of the video recordings, it was not possible for the blinded observer to analyze all participants. Mean age of the students who were evaluated for the global assessment score before TECA A was 25.8 years, 17 (65.3%) of them were male. For the time to compression parameter, mean age of participants was 25.8 years with 67.8% (n=19) male before TECA A, and 25.8 years with 66.6% (n = 18) male after TECA A. For time to defibrillation afte r TECA A, mean age of participants was 25.6 years, with 13 (61.9%) male.

Correlation coefficients between the assessment scores, time to start chest compressions and time to defibrillation registered by the two observers before and after the training are presented in Figure 2.

Discussion

Global assessment of the management of CA

The management of CA is based on the performance of a series of measures in a stressful scenario of the emergency department. For this reason, we chose an assessment instrument that could evaluate several points of the care algorithm, rather than a binary evaluation (e.g., failed/approved).

A clinical trial[9] published in 2018 showed that there were less deviations from ACLS guidelines in the resuscitation of patients who were discharged than of patients who did not survive to hospital discharge. The instrument enabled the analysis of different levels adherence to the guidelines. The use of a simulated clinical scenario aimed to identify the students' actions in a realistic CA situation, rather than assessing theoretical knowledge only. This is reinforced by a study[10] published in 2010 that showed a written evaluation is not a predictor of successful management of simulated patients.

There was no difference in the percentage of students who performed chest compression and defibrillation before and after TECA A. This could be explained by the fact that all students had taken the basic life support course in the first years of medical school. However, a median difference of 4.0 points in the global assessment of their performance before the training suggests a difficulty in progressing from basic to advanced life support, with a low adherence to CA guidelines before the training. After TECA A, the median score of the group was raised to 10.0, confirming the effectiveness of the training in improving the students' performance in a simulated CA situation.

Time to start chest compressions

Several evidences have shown that delays to chest compressions worsen the prognosis of CA patients and should be minimized. In 1985, a registry of 1,297 people with witnessed out-of-hospital CA was published, showing a higher survival rate in patients who received CPR before arrival of the emergency medical services (32% vs. 22%). Multivariate analysis revealed that this difference was mainly due to the initiation of CPR (1.9 minutes vs. 5.7 minutes; p< 0.001). In the subgroup of patients with VF, the initiation of CPR before arrival

Table 2 – Comparison of the global assessment scores, time to compression and time to defibrillation registered by observer in person and by the observer who was blinded to the training

Parameter	Time point	Observer in person	Blinded observer	p-value
Global assessment score	Pre (n = 26)	3.50(2.00-5.00)	3.00 (2.75-5.00)	0.947
	Post (n = 21)	10.00 (9.00-10.00)	10.00 (9.00-10.00)	0.877
Time to first compression (seconds)	Pre (n = 28)	31.00 (23.00-44.75)	30.00 (22.50-45.25)	0.921
	Post (n = 21)	21.00 (18.50-25.00)	21.00 (15.50-24.00)	0.511
Time to defibrillation (seconds)	Pre (n = 27)	82.00 (54.00-117.0)	85.00 (56.00-120.0)	0.808
	Post (n = 21)	50.00 (46.00-55.00)	50.00 (46.00-56.00)	0.9297

Continuous variables were analyzed by the Mann-Whitney Wilcoxon test and expressed as median an interquartile range (25-75%)

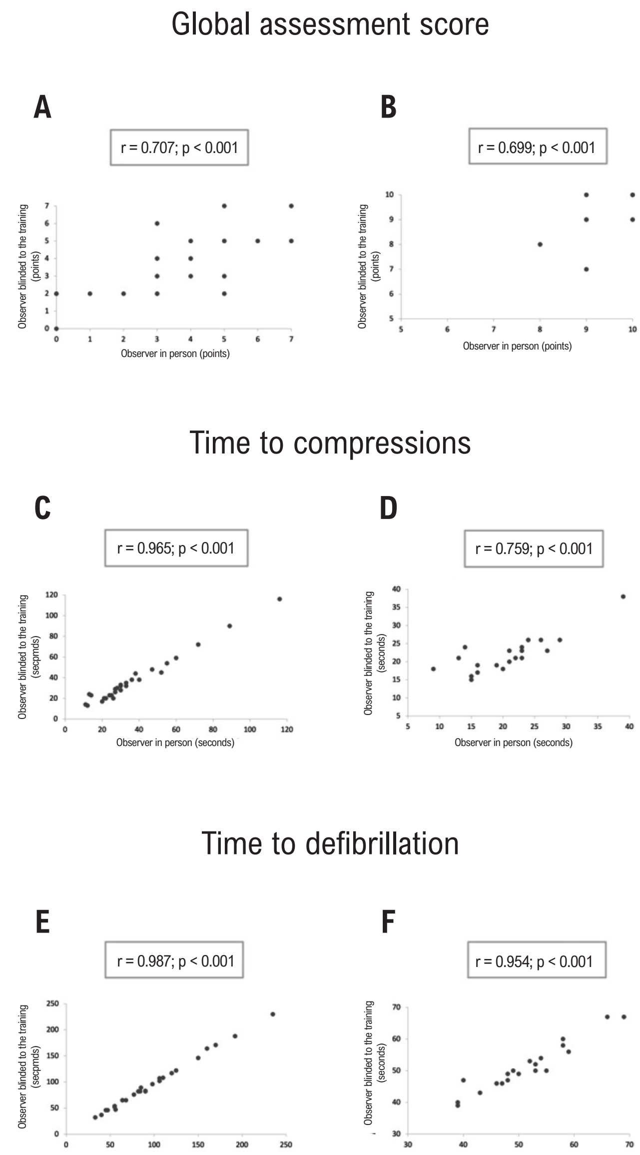

Figure 2 – Correlation between global assessment scores before (A) and after training (B), time to compression before (C) and after training (D), and time to defibrillation before (E) and after training (F) registered by the observer in person and by the blinded observer

of the emergency medical services was also associated with higher survival (37% versus 29%).[11] Another study published in 1985, involving 285 patients with witnessed CA due to VF showed that the time elapsed from collapse until initiation of basic life support was shorter in patients who survived to hospital discharge compared with those who died (3.6 minutes vs. 6,1 minutes).[12] In 2012, a study based on records of patients who experienced out-of-hospital CA in Japan was published.[13] A multivariate analysis showed that the presence of VF in the first assessment, access to an automated external defibrillator, and initiation of CPR before arrival of emergency medical services, and the lower response time to advanced life support were associated with better neurological outcome.[13] In 2015, a study on 7623 out-of-hospital CA patients between 2005 and 2011, identified through the nationwide Danish Cardiac Arrest Registry, was published. The study showed that early CPR was associated with higher survival rates, even in case of long response time of emergency medical services.[14] These data are consistent with 30-day survival analysis of 30,381 out-of-hospital CA witnessed in Sweden from 1990 to 2011. CPR performed before the arrival of emergency medical services was associated with a 30-day survival rate that was more than twice as high as that associated with no CPR (10.5 % vs. 4%), even after including time to defibrillation in the propensity score.[15]

In our study, median time to start chest compressions was reduced from 25 seconds before TECA A to 19 seconds after the training, indicating the course was effective in teaching the students to start the chest compressions sooner.

Time to defibrillation

In 2018, the Resuscitation Council Consortium published the results of a prospective study with data on CAs collected from 2011 to 2015 at nine regional centers. A total of 4115 out-of-hospital CAs was analyzed, 60.8% of them were shockable. Performance of defibrillation by a bystander at the site of collapse significantly increased hospital discharge rate (66.5% vs. 43%) and the likelihood of being discharged with favorable neuronal outcome (51.7% vs. 32.7%), compared with patients initially shocked by local emergency medical services.[16] This reinforces the positive impact of performing defibrillation as early as possible. A CPR program was implemented in the subway of Sao Paulo between 2006 and 2012, and data on CA events were prospective collected during this period. The period between the collapse and the first shock was the only variable independently associated with hospital discharge with minimal neurological deficit. An increase in the time to defibrillation from two to four minutes resulted in 87% decrease in the likelihood of hospital discharge (odds ratio = 0.13; 95% confidence interval: 0.05 – 0.38; P<0.001).[17]

Data of 6789 in-hospital CAs at 369 hospitals in the USA showed that the time to defibrillation is also crucial in this scenario. Delayed defibrillation (more than two minutes) was associated with a 52% reduction in the likelihood of discharge (22.2% vs. 39.3%). This was a graded and continuous association, which increases as the period between collapse and defibrillation increases.[18]

The TECA A promoted a 34.5-second reduction in the median time to the first shock, confirming that the objective of the course, to reduce the time to defibrillation, was achieved.

In addition to raising the global assessment score and reducing the time to first chest compression and defibrillation, TECA A promoted a reduction in the interquartile range values of all parameters assessed. This result showed that TECA A not only improved the performance of the students in a simulated CA situation, but also made knowledge of the students more even.

Study limitations

The assessment scores and the times were recorded openly, and only a small part of the sample underwent a blinded evaluation for performance. The lack of an observer blinded to the training performed by the students and to the stage of simulation for all participants was a limitation of the study. This bias reduces the strength of the study and could influence the results. However, the high degree of correlation between the information recorded by the observer in person and the information recorded by the blinded observer, and the absence of significant differences between these scores and times allow us to infer that the information recorded by the former did not have significant effect on the results.

An important objective of the training on the management of CA is to teach the trainees how to perform correct chest compressions, at a rate and to a depth recommended by guidelines. These parameters can be analyzed by specific tools of compression monitoring devices; our manikins did not allow an accurate assessment of these parameters, which was another limitation of the study.

In addition, we did not evaluate the acquisition of knowledge by the students over time since the post-training performance was assessed immediately after the TECA A. Thus, further studies designed for this aim are needed.

Conclusion

Completion of the TECA A was associated with higher adherence to CPR guidelines and shorter times between collapse and first chest compression and defibrillation. TECA A is a useful tool in the CPR training of healthcare professionals.

Author Contributions

Conception and design of the research: Furtado FN, Carvalho AC, Gonçalves Junior I, Almeida DR; acquisition of data: Furtado FN, Gonçalves RM; analysis and interpretation of the data: Furtado FN; statistical

analysis: Alfieri DF; writing of the manuscript: Furtado FN, Canesin MF, Almeida DR; critical revision of the manuscript for intellectual content: Canesin MF, Timerman S, Almeida DR.

Potential Conflict of Interest

No potential conflict of interest relevant to this article was reported.

Sources of Funding

There were no external funding sources for this study.

Study Association

This article is part of the thesis of Doctoral submitted by Fabrício Nogueira Furtado, from Universidade Federal de São Paulo.

Ethics Approval and Consent to Participate

This study was approved by the Ethics Committee of the Unifesp under the protocol number 1.113.016. All the procedures in this study were in accordance with the 1975 Helsinki Declaration, updated in 2013. Informed consent was obtained from all participants included in the study.

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