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Original Article

Implementation of a real-time qualitative app to evaluate resuscitation performance in an Advanced Cardiac Life Support course

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Abstract

Objective: In addition to high-quality chest compression, parameters of resuscitation efficiency such as early chest compression, early defibrillation, and decreased hands-off time are also vital in the Advanced Cardiac Life Support (ACLS) protocol. However, because of limited time and equipment in ACLS courses, efficiency of performance is difficult to evaluate. **Materials and Methods:** A free, easy-to-use iOS and Android app (CodeTracer®) was developed for real-time recording of cardiopulmonary resuscitation (CPR) performance. Interventions performed during resuscitation were set up as buttons. When the simulated scenario in the ACLS course began, instructors recorded every intervention and the team performed by pushing the appropriate buttons. When the scenario ended, the CodeTracer® automatically computed parameters, including the percentage of no-flow time, time to initiating CPR, and time to initiating defibrillation and also generated a graphic log for later discussion. **Results:** A total of 76 resuscitation episodes were recorded, 27 in the practice scenarios and 49 in the final Megacode simulations. After the course, the average percentage of no-flow time decreased 5.79%, time to initiating CPR decreased 3.05 s, and time to initiating defibrillation decreased up to 20.27 s. Of note, physicians as leaders seem to have better performance after the ACLS course than before, but the results were insignificant except for the percentage of no-flow time. **Conclusions:** CodeTracer® can record and calculate objective parameters for resuscitation performance in ACLS courses and can assist instructors in disseminating important concepts to participants. It can be a useful tool in ACLS courses.

Keywords: *Advanced cardiac life support, Android, CodeTracer, iOS*

Introduction

Advanced Cardiac Life Support (ACLS) protocols published by the American Heart Association are the standard of care for patients in cardiac arrest [1]. Studies reveal that good adherence to ACLS protocols is a determinant of return of spontaneous circulation (ROSC) [2,3]. While the presence of ACLS-trained personnel may increase the likelihood of ROSC and 1-year survival rates [4], resuscitation system errors are associated with decreased survival [5]. Scientific evidence indicates the advantages of ACLS protocols in critical situations and further emphasizes the importance of ACLS training courses.

In addition to high quality of chest compression (push hard and push fast), parameters of resuscitation efficiency such as early chest compression, early defibrillation, and decreased hands-off time are also vital in the 2015 ACLS protocol [1]. Although commercial products such as Resusci Anne® quality cardiopulmonary resuscitation (QCPR) can be used for automatic recording of CPR performance, these resources are not easily available, and real-time monitoring and recording of scenarios in ACLS courses are still difficult. As a result, the efficiency of performance in these scenarios is mostly evaluated subjectively by the instructor. There is no standard for correct responses, and since no objective parameters can be applied, participants may also be confused about their performance during debriefing and even after the course is complete.

This pilot study aimed to evaluate resuscitation performance using a simple mobile phone application. CPR logs can be recorded in real time and objective parameters can be calculated after the scenarios are complete. This application could

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be a good alternative in evaluating resuscitation performance and further assist in the improvement of resuscitation.

Materials and methods

Ethics statement

This study was initiated after its protocol was approved by the Institutional Review Board of Taipei Mackay Memorial Hospital, Taiwan and was conducted in conformity with the Declaration of Helsinki. Written informed consent was obtained from all participants before their enrollment in this study.

Study design

The study was a prospective, observational study investigating improvement in resuscitation performance in ACLS training courses. The hypothesis is that resuscitation performance would be improved objectively after participants complete the courses. We compared performance in the final Megacode simulations with performance in the practice scenarios during the courses. For the study interest, three objective parameters were chosen for evaluation: percentage of no-flow time, time to initiating chest compressions, and time to initiating defibrillation. Participants in two ACLS courses at Taipei Mackay Memorial Hospital were invited to participate. The course participants were qualified health-care professionals such as doctors or nurses with previous experience in performing CPR in clinical practice. All participants had certificates for basic life support before attending the courses.

Cardiac arrest scenario

Scenarios were administered by trained instructors. During the course, the participants completed practice scenarios and the final Megacode simulations in groups of 5–6. Each time, one of the participants was assigned to act as a team leader supported by the other members of the group. The team members followed the instructions from the team leader. Most of the cardiac arrest interventions (chest compression, airway management, rhythm interpretation, and defibrillation) were performed real time, while intravenous cannulation and drug administration were given as verbal instructions because of limitations in the use of manikins.

For the purpose of this study, only scenarios with initial shockable rhythms (i.e., ventricular fibrillation and pulseless ventricular tachycardia) were recorded for analyses. Practice scenarios and final Megacode simulations were conducted in real-time and instructors did not give suggestions or interrupt the progress in the middle of the scenario. Debriefing and discussions were held after each practice scenario.

Data collection using the mobile phone application

A free, easy-to-use iOS or Android app (CodeTracer®) was developed by Wistron Corporation, Taiwan, for real-time recording of CPR performance. The user interface is illustrated in Figure 1. Several interventions which would be performed during ACLS scenarios were set up as buttons; start/hold chest compression and ventilation (start/pause CPR), rhythm check (Rhythm), defibrillation (Defib), cardioversion (Shock), epinephrine administration (Epinephrine), and administering medications (Other drugs). A rhythm check or defibrillation/shock could not be recorded until CPR was paused [Figure 2].

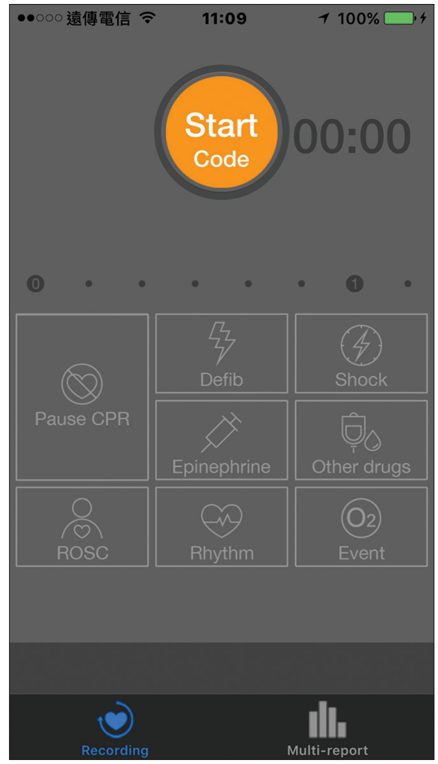

Figure 1: User Interface of the CodeTracer®

When the scenario began, instructors recorded every intervention the team performed by pushing the appropriate buttons. When the scenario ended, CodeTracer® automatically computed parameters including the percentage of no-flow time, time to initiating CPR, and time to initiating defibrillation and also generated a graphic log for later discussion [Figure 3]. In this study, two authors (Y. C. S. and M. Y. H.) were responsible for data collection during practice scenarios and final Megacode simulations. Each time the simulation scenarios ended, the instructors (Y. C. S. and M. Y. H.) showed the parameters recorded to the participants and discussed ways to improve their performance during the debriefing.

Statistical analysis

Continuous variables were compared with *t*-test, and categorical variables, with Chi-square test. Ninety-five percent confidence intervals (CI) and *P* values were reported. The $P < 0.05$ was considered statistically significant. All analyses were performed using Statistical Analysis Software for Windows, version V.9.2 (SAS Institute Inc., Cary, NC, USA).

Linear regression was used to evaluate improvement in resuscitation performance (i.e., percentage of no-flow time, time to initiating CPR, and time to initiating defibrillation) after adjustment for team leaders' positions (doctors or nurses). Because the same participants may be involved in both practice scenarios and final Megacode simulations, the generalized estimating equation method [6,7] was adapted to account for this potential clustering.

Results

A total of 49 participants were involved in this study. Among them, 13 (26.5%) were physicians. A total of

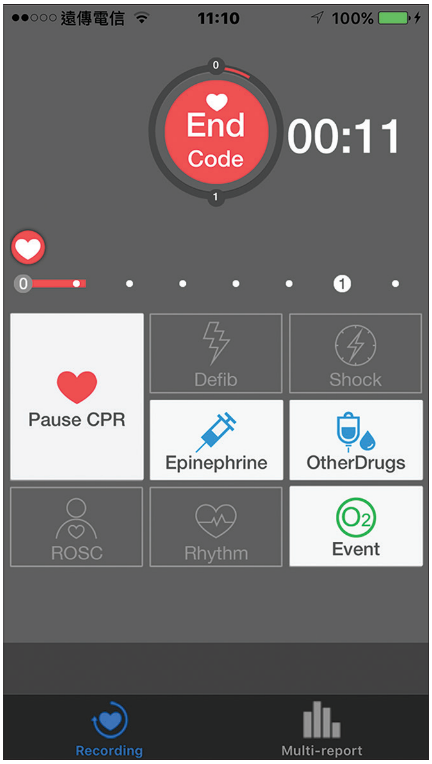

Figure 2: User Interface of the CodeTracer® during cardiopulmonary resuscitation

76 episodes of resuscitation were recorded, with 27 in the practice scenarios and 49 in the final Megacode simulations. Parameters including percentage of no-flow time, time to initiating chest compression, and time to initiating defibrillation were estimated by the CodeTracer® and are summarized in Table 1. After the course, participants had significant improvement in these parameters.

We further evaluated improvement in the resuscitation performance by adjusting for participants' positions. After the adjustments, the improvements in resuscitation performance were still statistically significant. After the course, the average percentage of no-flow time decreased 5.79%, time to initiating CPR decreased 3.05 s, and time to initiating defibrillation decreased up to 20.27 s. Of note, physicians as leaders seem to have better performance, after the ACLS course than before the course, but the results are being insignificant except for the percentage of no-flow time. The results are summarized in Table 2.

Discussion

In a recent study, McEvoy *et al*. found that adherence to ACLS protocols throughout an in-hospital cardiac arrest event is associated with increased ROSC. Moreover, both wrong actions and omissions of indicated actions are associated with decreased ROSC [2]. Although parameters associated with guideline adherence such as early defibrillation, early chest compression, and low percentage of no-flow time are commonly taught in a formal ACLS training course [8], efficiency of performance is difficult to evaluate. Without objective parameters, it is difficult for instructors to offer further feedback during debriefing, and the participants may not have

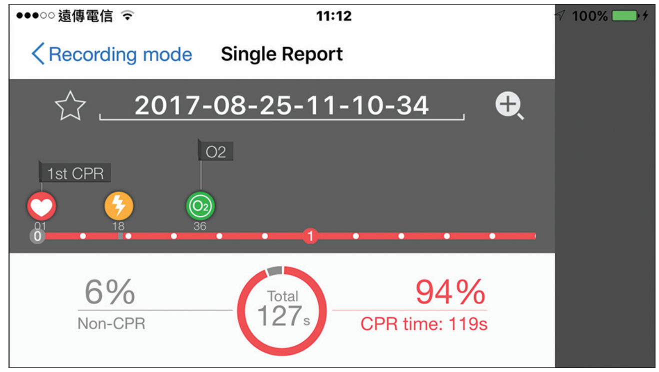

Figure 3: Cardiopulmonary resuscitation log of the CodeTracer®

Table 1: Evaluation results

	Practice scenarios (*n*=27)	Final Megacode simulations (*n*=49)	*P*
Doctors (%)	6 (22.2)	13 (26.5)	0.678
Percentage of no-flow time (SD)	27.4 (12.9)	21.4 (6.6)	0.03
Time to initiating CPR (s) (SD)	19.6 (7.4)	16.5 (6.4)	0.07
Time to initiating defibrillation (s) (SD)	68.6 (36.1)	48.1 (12.3)	0.008

CPR: Cardiopulmonary resuscitation, SD: Standard deviation

Table 2: Differences in resuscitation performance between final Megacode simulations and practice scenarios

Variables	Differences (SD)	*P*
Percentage of no-flow time (%)		
Physicians	−5.87 (1.96)	0.003
Final Megacode simulations	−5.79 (2.64)	0.029
Time to initiating CPR (s)		
Physicians	−2.03 (1.35)	0.133
Final Megacode simulations	−3.05 (1.56)	0.049
Time to initiating defibrillation (s)		
Physicians	−3.58 (4.36)	0.411
Final Megacode simulations	−20.27 (6.62)	0.002

CPR: Cardiopulmonary resuscitation, SD: Standard deviation

confidence about their performance. This results in low retention rates of skills, which is commonly observed after ACLS training courses [9-11].

To the best of our knowledge, this is the first study using a mobile phone application to assist in evaluation of resuscitation performance in an ACLS course. The whole scenario was recorded as a time-flow log and all actions were recorded for further discussion and suggestions. Wrong steps such as the drug-shock sequence can be corrected in later practice, and the participants can adjust their actions more precisely based on the automated calculated parameters. After the training, all these objective parameters were improved, indicating good resuscitation performance after the ACLS course.

For the future ACLS courses, application-assisted teaching can have other benefits. First, objective standards could be set up for parameters. Thus, the scoring system could also be automated, in the next version of CodeTracer® and evaluation of pass/fail in the Megacode test would be more objective. Second, resuscitation logs could be saved for each participant's own records and retention of skills could easily be compared and evaluated using these logs.

Several limitations must be addressed in this pilot study. First, not all simulation scenarios were recorded because of limited time. However, even participants whose performances were not recorded still benefited from repeated debriefing and feedback during simulation sessions. Second, although the study interest was demonstration of application-assisted evaluation of ACLS courses, we did not divide participants into intervention (application-assisted) and nonintervention groups. As a result, we cannot conclude that the resuscitation performances in our study group were better compared with those using traditional methods. Neither can we conclude that if the skill retention rate will be higher in our study group. This kind of design may show up in the later study. Third, we did not have data from real patients who experienced CPR performed by our trained personnel after the study. As a result, we could not evaluate the significance of survival benefits with real patients. Finally, we did not evaluate the reasons for behavior changes behind the improvements in CPR parameters. Questionnaires may be used to evaluate these psychomotor factors which may further improve course delivery in the future studies.

Conclusions

CodeTracer® can record and calculate objective parameters of resuscitation performance in ACLS courses and may assist instructors in disseminating important concepts to participants. It can be a useful tool in ACLS courses.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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