

Knowledge and experience of cardiopulmonary resuscitation among cardiologists in clinical practice: A multicenter cross-sectional study

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ABSTRACT

Objective: This study aimed to investigate the theoretical knowledge and clinical experience of cardiopulmonary resuscitation (CPR) among Turkish cardiologists according to the recommendations of the 2015 European Resuscitation Council (ERC) guidelines.

Methods: A total of 120 cardiologists from 14 different medical centers (six university and eight research-education hospitals) in İstanbul were included in the study. The questionnaire consisting of 29 open-ended and multiple choice questions on CPR was used and validated based on the ERC guidelines published in 2015. The percentage of correct answers was calculated for each participant.

Results: Of the 120 cardiologists included in this study, 108 (90%) accepted the participation, and the median percentage of correct answers for theoretical questions was 53% (38-72). The percentage of correct answers for interventional cardiologists (48%, n=52) was significantly higher [60% (50-66) vs. 46% (38-52), p<0.001]. Regarding the type of medical centers, no statistical difference was found in terms of theoretical knowledge on CPR [57% (50-72) university hospitals vs. 49% (41-57) research-education hospitals, p=0.160]. Peri-arrest transthoracic echocardiography was used in 71% of cases. The ratio of participants who had received an advanced cardiac life support course in the preceding year was only 19% (n=20), and those participants had a significantly higher score regarding the CPR theoretical knowledge questions [68% (54-70) vs. 46% (38-51), p<0.001].

Conclusion: The theoretical knowledge of cardiologists on CPR is not satisfactory according to the 2015 ERC guidelines. An increased frequency of CPR training courses may improve this result. (*Anatol J Cardiol* 2019; 21: 296-304)

Keywords: cardiac arrest, cardiopulmonary resuscitation, cardiologist

Introduction

Sudden cardiac arrest (SCA) is one of the leading causes of death worldwide (1). Early recognition and immediate cardiopulmonary resuscitation (CPR) are critical for successful resuscitation of victims. Once SCA has developed, prompt initiation of CPR, including defibrillation within 5 min, can increase survival rates as high as 50%–70% (2). To achieve this, it is essential to perform CPR according to current guidelines (3, 4). Numerous clinical studies have emphasized the importance of evidence-based CPR to improve the SCA survival (5, 6). The ERC guidelines are based on the International Liaison Committee on Resuscitation documents and recommendations, which are updated every 5 years. The most recent ERC guidelines on CPR were published in 2015 and were updated in 2017 (7, 8).

Cardiologists are expected to have sufficient knowledge and skills in CPR because they encounter many conditions that can

cause SCA. In many European countries, successful completion of advanced cardiac life support (ACLS) is required to work as a cardiologist (9). A standardized approach to the management of patients having SCA decreases morbidity and mortality. However, in Turkey, these issues have not been sufficiently evaluated in the literature.

In this study, we surveyed Turkish cardiologists on their knowledge and adherence to resuscitation guidelines following the 2015 ERC guidelines and the updated version published in 2017. In addition, we also assessed the CPR experiences of cardiologists in daily practice.

Methods

In this study, the necessary sample size was calculated as 106 cardiologists, assuming a (0.55) Cohen's effect size with the significance level of .05 and a power of .8 (10). Using a convenience

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sampling that included 120 cardiologists, who worked in cardiology services of 14 university and research-education hospitals in İstanbul, 108 cardiologists responded to the questionnaire after being explained the study purpose. All questions were prepared by the authors of the present study, and any question on which an agreement about the correct answer could not be easily achieved was excluded from the questionnaire. The questionnaire was also discussed with a group of five ACLS experts. The questions that were not clear were also removed from the questionnaire. The reliability of the questionnaire was validated using a test-retest procedure. Twenty of the previously surveyed cardiologists not included in this study were invited for a second interview after 1 week. The median level of answer consensus was 94% between the two groups of results (range, 92%–98%; standard deviation, 3%). All information in the questionnaire covered the following three areas: (1) demographic features; (2) resuscitation experiences in hospital; and (3) theoretical knowledge on CPR in hospital. Theoretical multiple choice questions (n=21) were prepared that addressed various subjects on CPR in hospital following the 2015 ERC guidelines (Appendix A). Each of the questions assessing theoretical knowledge was followed by four possible answers, of which only one was correct. The percentage of correct answers for theoretical questions was calculated for each participant according to the following formula: [(total number of correct answers)/(total number of theoretical questions) x100]. The questionnaire was applied to each cardiologist by the authors. Data collection was performed from August 2018 to October 2018. All participants included in the study provided informed consent. Ethical Board approval was obtained from our Local Ethics Committee.

Statistical analysis

Statistical Package for the Social Sciences software (SPSS, version 21, SPSS Inc, Chicago, IL, USA) was used for all statistical calculations. A power analysis was performed using the G*Power version 3.0.10. All data were expressed as the mean±standard deviation or median with an interquartile range

Table 1. Demographic characteristics of the study population

| | |
|---------------------|----------|
| Gender | |
| Male | 69 (64%) |
| Female | 39 (36%) |
| Age, years | 34±6 |
| Years in speciality | 9±4.8 |

for continuous variables, and as a percentage for categorical variables. The Kolmogorov–Smirnov test was used to determine the normality of the variable distribution. Because the data were not normally distributed, the Mann–Whitney U test was used for the comparisons of the two groups. For all tests, a p-value of <0.05 was considered statistically significant.

Results

Of the 120 participants, 108 (69 males, 39 females; 90%) physicians accepted to participate in the study. The demographic characteristics of the study population are shown in Table 1. For the theoretical knowledge questions, the participants' median percentage of correct answer was 53% (38-72). The ratio of interventional cardiologists that participated in the study was 48% (n=52), and the median percentage of correct answers for interventional cardiologists was significantly higher than for the non-invasive cardiologists [60% (50-66) vs. 46% (38-52), p<0.001]. Although, the median percentage of correct answers for cardiologists working in university hospitals was higher than the cardiologists working in research-education hospitals, it was not statistically significant [57% (50-72) vs. 49% (41-57), p=0.160]. The ratio of physicians who had attended an ACLS course in the preceding 12 months was only 19% (n=20), and these participants had a significantly higher score in the CPR theoretical knowledge questions [68% (54-70) vs. 46% (38-51), p<0.001] (Table 2).

Table 2. Comparison of theoretical knowledge on CPR between cardiologists

| Speciality in cardiology | n (%) | The median percentage of correct answers (%) | P-value (*) |
|--|----------|--|-------------|
| Invasive | 52 (48%) | 60 (50-66) | 0.001 |
| Non-invasive | 56 (52%) | 46 (38-52) | |
| Institution | | | |
| University hospital | 46 (43%) | 57 (50-72) | 0.160 |
| Education-research hospital | 62 (57%) | 49 (41-57) | |
| ACLS course attendance (In the preceding 12 months) | | | |
| Yes | 20 (19%) | 68 (54-70) | 0.001 |
| No | 88 (81%) | 46 (38-51) | |

(*) The Mann-Whitney U test was used for the comparison of groups and expressed by median with interquartile range.
 ACLS - advanced cardiac life support

The percentage of early defibrillation as defined within 3-5 min of SCA, was 66%. The routine use of peri-arrest transthoracic echocardiography (TTE) was 71%. Only 26% of the cardiologists reported that they were properly skilled in advanced airway management, such as tracheal intubation. None of the participants were aware of using waveform capnography to confirm the quality of CPR. One-third of the participants were routinely using sodium bicarbonate during CPR. All physicians were using manual defibrillators with the biphasic waveform. The median time of withdrawing CPR in the absence of reversible cause was 40 (30–60) min. After withdrawing resuscitation in case of a CPR failure, 89 cardiologists (82%) reported that they had never informed the relatives of patients about organ donation.

Discussion

In this study, we evaluated the level of theoretical knowledge and experiences of Turkish cardiologists on CPR in hospital and revealed that they had knowledge gaps regarding the 2015 ERC guidelines. We also found that training courses on CPR among the cardiologists were so far below the desired level.

Our findings are consistent with other studies among other types of health care professionals. Galinski et al. (11) observed insufficient theoretical knowledge of Basic Life Support between physicians and nurses who responded to a questionnaire in a 450-bed French university hospital. Diaz et al. (12) applied a questionnaire to 63 family physicians showing that they had deficiencies, especially in airway management and insufficient resuscitation-training performance. Pantazopoulos et al. (13) reported that cardiologists have theoretical knowledge gaps regarding the 2005 American Heart Association Resuscitation Guidelines, and the level of theoretical knowledge had diminished 1 year after the training course. Wheatley et al. (14) showed that physicians who had attended a formal training program had higher percentages of correct answers compared with other groups. Kiyani et al. (15) demonstrated that there was a positive correlation between the level of theoretic knowledge and clinical application on CPR. Filgueiras Filho et al. (16) concluded that theoretical knowledge on CPR was higher among physicians who had attended the ACLS course and cardiologists showed a higher theoretical knowledge on the care of patients who had cardiac arrest compared to other physicians in the fields of internal medicine, surgery, and orthopedics. Our present study and the majority of current literature is consistent with our findings, which reveal that the training courses had significantly improved the theoretical knowledge and had a significant impact on the CPR quality.

In contrast, a Canadian controlled multicenter intervention study evaluated the effect of the ACLS training in paramedics and showed that when a rapid defibrillation program had been previously implanted, the introduction of ACLS training in the setting of pre-hospital care had not decreased mortality (17). Although it seems like a conflict between the studies, it might be

interpreted as indicating that the survival after CPR depended on not only the educational measures, but that it was also related to the implementation of the CPR theoretical knowledge in routine practice. The intervals for retraining CPR differ according to the characteristics of the physicians, and the optimal period is still unknown. According to the 2015 ERC guidelines, frequent low-dose retraining is recommended to prevent the deterioration of CPR skills.

In our study, the theoretical knowledge of interventional cardiologists was better than in physicians from other disciplines. In clinical practice, during the coronary interventions, it is expected to encounter cardiac arrest cases more often. Therefore, interventional cardiologists might update their knowledge on CPR that might be used in performing CPR in an acceptable manner. In our study, the use of TTE during CPR was 71%. Many studies have investigated the role of TTE during CPR (18-20). Although no studies have proven that the use of TTE improves survival, it is clear that TTE has the potential to detect reversible causes of cardiac arrest. The implementation of TTE into CPR requires a proficiency to minimize the interruptions of chest compressions.

The present study revealed that none of the participants had used waveform capnography, and 67% did not know what this was. The benefits of waveform capnography during CPR include the confirmation of the tracheal tube placement and monitoring the ventilation rate and the quality of chest compressions (21). It is also useful to identify the return of spontaneous circulation. In the 2015 ERC guidelines, there is a great emphasis on the use of waveform capnography. In our study, only 26% of the participants were confident in their tracheal intubation skills, which is the most secure and effective way to establish and maintain the ventilation. According to the 2015 ERC guidelines, tracheal intubation should be performed only by those who are trained, competent, and experienced in this application. In the absence of staff skilled in tracheal intubation, a supraglottic airway is another alternative according to the recommendations of the same guidelines. The best airway, or a combination of airway techniques might differ according to many factors, such as the patient status, time of the resuscitation attempt, and the skills of the physicians (22). Dramatically, one-third of the cardiologists were giving sodium bicarbonate during the CPR in their daily practice. There is no evidence for using this drug in the absence of life-threatening hyperkalemia and tricyclic overdose (23, 24).

In our study, the decision to terminate CPR was longer than the guidelines recommendation. Although it is reasonable to withhold CPR in adults in case of asystole for more than 20 min despite ongoing ACLS in the absence of a reversible etiology, cardiologists are more insistent than other health care professionals. This might be because most of the victims suffering from cardiac arrest in the hospital have a reversible cause, such as acute coronary syndrome and rhythm disturbance. Therefore, cardiologists working in coronary intensive care units or catheterization laboratories might extend the CPR duration. Another interesting finding of this study was the reluctance of physicians

with regard to the perspective of organ donation. Although the primary goal of CPR is to save the patient's life, organ donation should be considered in patients when CPR is not successful in achieving spontaneous circulation (25, 26). In the case of a CPR failure, all physicians should make efforts to increase the rates of organ donation considering legal and ethical issues.

Study limitations

Our study has several limitations. First, our study sought to assess only the resuscitation theoretical knowledge and experiences on CPR and did not evaluate the cardiologists' practical skills. Second, the questionnaire was composed of a limited number of questions, so all components of CPR were not included. Third, because there is no accepted objective form to evaluate the theoretical knowledge, a selection bias might have occurred during the determination of topics in the questionnaire. Finally, the number of cardiologists included in our study was relatively small, and cardiologists who are working in state hospitals and private hospitals were not included in the study.

Conclusion

Based on the present study, we can conclude that the level of theoretical knowledge on CPR among cardiologists is not satisfactory considering the recommendations of the ERC guidelines published in 2015. Training courses might improve the quality of CPR and increase the survival rates after cardiac arrest.

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Appendix A. Advanced cardiac life support (ACLS) and cardiopulmonary resuscitation (CPR) experiences and theoretical knowledge questions

Gender:

Birth date:

Institute:

Years in cardiology:

Specialized in invasive cardiology:

1. Which is the optimal depth of chest compression during CPR?

- a) 2–3 cm
- b) 3–4 cm
- c) 4–5 cm
- d) 5–6 cm

2. Which is the optimal rate of chest compression per minute during CPR?

- a) 60–80/min
- b) 80–100/min
- c) 100–120/min
- d) 120–140/min

3. Which is the optimal ratio of compression–ventilation during CPR for a single provider?

- a) 15:1
- b) 15:2
- c) 30:1
- d) 30:2

4. Which is the optimal ventilation rate of the lungs per minute during CPR?

- a) 6/min
- b) 8/min
- c) 10/min
- d) 12/min

5. Which is the maximal interruption time in chest compression during defibrillation?

- a) 5 seconds
- b) 10 seconds
- c) 15 seconds
- d) 20 seconds

6. Which are two correct answers in terms of reversible causes for cardiac arrest known as 4Hs and 4Ts that must be identified during CPR?

- a) Hypoxia–thyrotoxicosis
- b) Hypoglycemia–tamponade
- c) Hypovolemia–thrombosis
- d) Hypertension–toxins

7. Which is the initial step of CPR when you encounter a victim of cardiac arrest?

- a) Start chest compression.
- b) Open the airway.
- c) Alert emergency services.
- d) Ensure the safety of victim and rescuer.

- 8. Which is the optimal hand position for chest compression during CPR?**
- Lower half of the sternum
 - Upper half of the sternum
 - Upper abdomen (epigastrium)
 - The bottom end of the sternum (breastbone)
- 9. Which is the optimal chest compression fraction (time of chest compression per minute/total time of CPR per minute) during CPR?**
- >40%
 - >50%
 - >60%
 - >70%
- 10. Which is the optimal time interval to check the rhythm during CPR?**
- 60 seconds
 - 90 seconds
 - 120 seconds
 - 180 seconds
- 11. Which is the optimal range of the arterial blood oxygen saturation during CPR?**
- 86%–90%
 - 90%–94%
 - 94%–98%
 - 98%–100%
- 12. Which is the optimal time interval to consider changing rescuers during CPR?**
- 1 minute
 - 2 minutes
 - 3 minutes
 - 4 minutes
- 13. Which of the following interventions has no impact on mortality during CPR?**
- Immediate and proper basic life support
 - High-quality chest compressions without interruption
 - Early defibrillation
 - Advanced airway management
- 14. Which of the following are shockable rhythm patterns causing cardiac arrest during CPR?**
- Ventricular fibrillation
 - Asystole
 - Pulseless electrical activity
 - Pulseless ventricular tachycardia
- a) I and II b) I and IV c) II and III d) I, III, and IV
- 15. Which of the following is an effective route if intravenous access is difficult or impossible during CPR?**
- Intracardiac
 - Intratracheal
 - Intraosseous
 - Intracavitary

16. Which is the initial step in case of a cardiac arrest in the catheterization laboratory during PCI?

- a) Deliver 3 consecutive shocks.
- b) Start chest compression.
- c) Give intravenous amiodarone.
- d) Give intravenous adrenaline.

17. Which of the following is the most common cause of non-cardiac arrest?

- a) Hypovolemia
- b) Asphyxia
- c) Anaphylaxis
- d) Hypothermia

18. Which is the least energy threshold value for the initial shock by a biphasic defibrillator?

- a) 50J
- b) 100J
- c) 150J
- d) 200J

19. Which of the followings are optimal post-resuscitation targets in case of patients who achieved spontaneous circulation after CPR?

- I. Systolic blood pressure >100 mm Hg
- II. Body temperature 32–36°C
- III. Urine output (1 mL/kg/h)
- IV. Blood glucose <180 mg/dL (avoid hypoglycemia)

- a) I, II, and III
- b) I, II, and IV
- c) I, III, and IV
- d) I, II, III, and IV

20. What are the recommended dosage and optimal time period of amiodarone in case of persistent ventricular fibrillation or pulseless ventricular tachycardia during CPR?

- a) 150 mg amiodarone after 3 shocks
- b) 300 mg amiodarone after 5 shocks
- c) 150 mg amiodarone after 5 shocks
- d) 300 mg amiodarone after 3 shocks

21. Which of the following agents can replace amiodarone in the management of ventricular fibrillation if amiodarone is not available during CPR?

- a) Metoprolol
- b) Vasopressin
- c) Adenosine
- d) Lidocaine

22. Which of the following types of defibrillators are used in your clinics?

- a) Monophasic with self-adhesive defibrillation pads
- b) Biphasic with self-adhesive defibrillation pads
- c) Monophasic with paddles
- d) Biphasic with paddles

23. Which of the following options do you use in airway management during CPR?

- a) Tracheal intubation
- b) Supraglottic airways devices (laryngeal mask airway, laryngeal tube, etc.)

- 24. Are you aware of the existence of waveform capnography to monitor the quality of CPR?**
- a) Yes
 - b) No
- 25. Do you use waveform capnography to monitor the quality of CPR in your clinical practice?**
- a) Yes
 - b) No
- 26. Which of the following medical agents do you use routinely during CPR? (More than one can be marked)**
- a) Adrenaline
 - b) Amiodarone
 - c) Sodium bicarbonate
 - d) Magnesium sulfate
 - e) 0.9% sodium chloride
 - f) 5% dextrose
- 27. How long after do you decide to stop CPR in case of asystole for more than 20 min despite ongoing advanced life support, in the absence of a reversible cause? (Please notify as minutes)**
-
- 28. Do you inform the patients' relatives about organ donation when CPR is not successful in achieving spontaneous circulation?**
- a) Yes
 - b) No
- 29. Did you attend advanced cardiac life support (ACLS) training in the preceding year?**
- a) Yes
 - b) No