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Dispatcher-Assisted Bystander Cardiopulmonary Resuscitation (Telephone-CPR) and Outcomes after Out of Hospital Cardiac Arrest

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ABSTRACT

Objective: To determine the effects of the implementation of the telephone cardiopulmonary resuscitation (T-CPR) program on the outcomes of out-of-hospital cardiac arrest (OHCA).
Methods: In this prospective study, Emergency Medical Service (EMS) dispatchers and all bystanders attending to patients with OHCA were included. The consensus sampling was carried out based on inclusion and exclusion criteria. The data collection tool was consisted of a demographic questionnaire for patients and bystanders accompanied by a checklist for CPR outcomes. Data were collected 6 months before and after the implementation of the T-CPR program and analyzed using SPSS version 18.
Results: The results revealed that the percentages of successful and unsuccessful CPR cases before the implementation of the T-CPR program were 28.1% and 71.9%, respectively. However, in total, 32% and 67.8% of the CPR cases were successful and unsuccessful, respectively, after the implementation of the mentioned program. The survival rate increased from 56.5% in the pre-intervention phase to 72.4% in the post-intervention one. In terms of the outcomes, brain complications decreased from 40% in the pre-intervention phase to 32.1% in the post-intervention one; however, the Chi-square test showed no significant difference in terms of CPR outcomes in the two time periods (p=0.797).
Conclusion: According to the results, it is recommended that T-CPR programs be developed and dispatchers be trained in the area of this research. The results could be regarded as a guide to EMS managers, healthcare professionals, and the basis for further studies on this subject.

Keywords: Telephone cardio pulmonary resuscitation (T-CPR); Dispatchers; Bystanders; Hospital cardiac arrest.

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Introduction

Cardiac arrest refers to the cases where the function of the heart stops suddenly and does not produce an effective heart rate and blood flow [1]. Over half of the cases of cardiac arrest occur out of hospitals in the US [2]. In Iran, there are no exact statistics in this regard to be cited. The survival probability of patients with cardiac arrest is directly related to the start of the first aid, especially the CPR process [3]. CPR refers to a series of measures, through which the hypoxia of vital organs, such as the heart and brain can be prevented and if done timely and properly, in addition to saving the person's life, it will prevent many irrecoverable injuries [4].

The American Heart Association (AHA) has been focusing on out-of-hospital CPR since 1960, and CPR guidelines have been updated eight times since 1966. Recent changes were made to the CPR process in 2015 by emphasizing not only the previous trend, but also the number, depth, and quality of chest compressions [5]. In an update to the CPR guidelines of AHA, there has been an emphasis put on initiating a CPR process within the first 3-5 minutes (the golden time), educating the public, and learning the basics of the CPR process and first aid by all community members, before the arrival of the emergency medical team [6]. Although many countries have adopted some training measures in the field of CPR at the public level, there are still so many shortcomings [7] that 84% of cardiac arrests occur at the presence of bystanders in European countries, with CPR performed only in 28% of the cases before the arrival of ambulances [8]. According to the results of the study carried out in Sweden by Bohm *et al*., the T-CPR protocol was implemented only in half of OHCA cases [9]. There is no study or statistic to be cited in Iran in this regard.

According to AHA's recommendations contained in the 2015 guidelines, untrained and nonprofessional bystanders should, with or without the dispatcher's guidance, perform CPR on patients with cardiac arrest only through chest compression [10]. Medical emergency dispatchers play a crucial role in the early detection of cardiac arrest and the faster initiation of CPR by bystanders [11]. AHA has emphasized the need for following T-CPR guidelines and training emergency medical dispatchers in the method of diagnosing cardiac arrest and providing necessary guidelines, since 2010 [5, 10]. In this regard, the results of the study by *Bobrow et al.,* showed the positive effects of the CPR process, especially the survival rate, on the implementation of T-CPR protocols [12].

Although there have been some studies on CPR-related outcomes in Iran [4, 13], no study has yet been conducted on the implementation of CPR by bystanders or T-CPR by dispatchers, except for the one done by Dianati *et al.,* Although this study assesses the effects of T-CPR directly, it acknowledges that a few patients with cardiac arrests undergo CPR by bystanders [6]. Therefore, considering the limited number of the studies and the importance of the fast start of CPR, the current study was done aimed at determining the effects of implementing the T-CPR program on the outcomes of the out-of-hospital cardiac arrest (OHCA).

Materials and Methods

Study Population

In this prospective study, the research population consisted of all dispatchers working at the EMS dispatch center in an urban area of Iran (N=10, with two dispatchers at each six-hour shift work) and all bystanders attending the bedside of patients with OHCA. Census sampling was carried out. The patient's OHCA based on the diagnosis of emergency medical technicians (EMT) in both phases of the study, the receiving of the T-CPR training by callers, and the performing of chest compression by bystanders before the arrival of the EMTs in phase 2 formed the inclusion criteria. The exclusion criteria also included traumatic patients and the subjects below 8 years of age. From among ethical considerations considered in this study, one can refer to the obtaining of necessary permits, receiving the code of ethics from the Ethics Research Committee of Rafsanjan University of Medical Sciences (IR.RUMS.REC.1396.70), explaining the purpose of the study to the subjects, and keeping the information of the individuals included as confidential.

Study Protocol

The data collection tool included a demographic questionnaire for patients and bystanders (Appendices A and B) and a CPR outcome checklist (Appendix C) which was completed by the researcher (the first author). The questionnaire and the checklist were prepared based on the literature review, with their content validity confirmed in accordance with the opinion of the experts. The patient survival was confirmed according to the discharge criterion, the brain function was examined based on the cerebral performance category (CPC) by an educated nurse who was not in the research team and blind to the study, and finally heart failure was diagnosed by a cardiologist (the fourth author). To delineate the procedure, based on the information available at the Medical Archive of the EMS center, a statistical report was gathered from all patients and bystanders who had contacted "115", i.e. the emergency department, 6 months prior to the start of the intervention and to whom an ambulance had been dispatched and resuscitation had been conducted with the diagnosis of OHCA, based on the diagnosis by the emergency medical technician (EMT) in recorded conversations and patients' medical records. All conversations, mission forms, and medical records of resuscitated patients who had been transferred to the hospital

were recorded and examined. In the post-intervention phase, after the transfer of the patient to the hospital, the questionnaire was completed.

The researcher then conducted training sessions on T-CPR based on the latest American Heart Association guidelines (2015) for all dispatchers working at the EMS center (n=10). The training focused on the basic CPR (chest-compression-only) and its implementation through telephone training. For this purpose, in cases of the calls where the dispatcher suspected cardiac arrest, he would first ask the caller to go to the bedside of the patient and call out the patient's name; if there was no reaction, he would have to immediately call out the patient's name while patting on the patient's shoulders with both hands. If the patient did not react, he would have to look at the patient's chest, and if it did not go up and down naturally, he would assume that the patient was suffering from cardiac arrest and followed the dispatcher's recommendations (i.e., helping the patient lie down on a flat and tight surface, putting one's hands at the center of the patient's chest and applying pressure on the chest whenever the dispatcher started counting, trying not to bend one's elbows, applying pressure non-stop, and letting the chest get back to its normal position after each pressure). After completing the training program, all dispatchers were requested to apply the protocol to all patients with OHCA who had contacted the center. For a 6-month period, all cases diagnosed with OHCA by dispatchers and the ones who underwent the T-CPR protocol were gathered. The bystanders who refused to receive phone training or did not conduct chest compression before the arrival of the EMT were excluded from the study.

Statistical Analysis

Data were collected 6 months before (82 cases) and 6 months after the implementation of the T-CPR program (90 cases). Sampling was performed using census method. Data analysis was carried out by descriptive statistics (number and percentage) and analytical statistics (Chi-square test and the Fisher's exact test) using SPSS version 18.0 for Windows (SPSS Inc., Chicago, IL, USA). A two-sided p-value of less than 0.05 was considered the significance level.

Results

The demographic features of the patients showed that the majority of the patients were male aged over 60, and the most common causes of OHCA were cardiovascular problems in pre- and post-intervention periods. There was no significant difference observed regarding these features in the two time periods mentioned above (Table 1). The majority of the bystanders included men and first degree relatives in both pre- and post-intervention stages. There was no statistically significant difference among those features at both pre- and post-intervention stages, except for the variable of age (Table 2).

The results revealed that the number of telephone contacts with the EMS center during the 6-month period before the implementation of the T-CPR program was 187 with 82 cases of which being related to OHCA (based on the EMT's diagnosis) and meeting the inclusion criteria, of which 23 (28.1%) and 59 (71.9%) cases were successful and unsuccessful CPR, respectively. In addition, the number of telephone contacts with the EMS center

Table 1. Demographic characteristics of patients with OHCA before and after the intervention

Variables	Times	Pre-intervention		Post-intervention		*p* value
		Number	Percent	Number	Percent	
Gender	Male	52	63.4	60	66.7	0.655[a]
	Female	30	36.6	30	33.3	
Age (year)	≤60	25	30.5	39	43.3	0.082 [a]
	>60	57	69.5	51	56.7	
Place of OHCA	Home	74	90.2	76	84.4	0.255 [a]
	Others	8	9.8	14	15.6	
Contact Time	06-12	18	22.0	29	32.2	0.456 [a]
	12-18	23	28.0	19	21.1	
	18-24	26	31.7	27	30.0	
	00-06	15	18.3	15	16.7	
Causes of OHCA	Cardiac	37	45.1	51	56.7	0.265[b]
	Respiratory	13	15.9	19	21.1	
	Brain	12	14.6	7	7.8	
	Cancer	4	4.9	2	2.2	
	Poisoning	5	6.1	5	5.6	
	Others	11	13.4	6	6.6	
History of Heart Diseases	Yes	44	53.7	54	60	0.401 [a]
	No	38	46.3	36	40	

[a]Chi-square Test; [b]Fisher's exact test

Table 2. Demographic characteristics of bystanders before and after the intervention

Variables	Times	Pre-intervention		Post-intervention		*p* value
		Number	Percent	Number	Percent	
Gender	Male	58	70.7	63	70.0	0.916 [a]
	Female	24	29.3	27	30.0	
Age (year)	≤40	40	48.8	62	68.9	0.007 [a]
	>40	42	51.2	28	31.1	
Job	Heath Care Provider	4	4.9	0	0	0.051 [b]
	Others	78	95.1	90	100.0	
Educational Level	Middle School and Lower	21	25.6	26	28.9	0.101 [a]
	High School	35	42.7	48	53.3	
	University Degree	26	31.7	16	17.8	
Familial Relationship	First-Degree	69	84.1	71	78.8	0.652 [b]
	Second-Degree	9	11.0	14	15.6	
	Others	4	4.9	5	5.6	
First aid Courses	Yes	9	11.0	4	4.4	0.106 [a]
	No	73	89.0	86	95.6	

[a]Chi-square Test; [b] Fisher's exact test

during the 6-month period after the implementation of the T-CPR program was 133 cases with 90 cases of which having been related to OHCA (based on the EMT's diagnosis) and meeting the inclusion criteria, of which 29 (32.2%) and 61 (67.8%) cases were successful and unsuccessful CPR, respectively. However, the Chi-square test did not show a significant difference between the outcomes of CPR in the two above-mentioned time periods (the Chi-square test, p=0.55). Considering CPR outcomes, the survival rate increased from 56.5% in the pre-intervention phase to 72.4% in the post-intervention phase in terms of successful CPR cases. As regards the outcomes, brain complications decreased from 40% in the pre-intervention phase to 32.1% in the post-intervention one. However, the Chi-square test showed no significant difference in terms of CPR outcomes in the two mentioned time periods (Table 3).

Discussion

The results of the present study showed that the number of successful CPR cases in the post-intervention phase increased by 1.4% in contrast to the pre-intervention phase. The survival rate of the patients with successful CPR cases in the post-intervention phase increased by 15.9% compared with the pre-intervention period. Brain complications and CPR-related complications decreased by 7.9% and 7.5%, respectively. Although these changes were not statistically significant, all results were clinically significant, reflecting the positive effects of the implementation of the T-CPR program on CPR outcomes.

Although there was no similar Iranian study on this subject, some studies have been done on it abroad. In addition, the results of the study by Besnier et al., [14] showed that the survival rate increased by 13%

Table 3. Distribution of CPR outcomes in patients with successful CPR

Variables	Times	Pre-intervention		Post-intervention		*p* value
		Number	percent	Number	Percent	
Shockable Rhythm	Yes	20	24.4	29	32.2	0.256 [a]
	No	62	75.6	61	67.8	
Return of Spontaneous Circulation	ROSC ≤20 Minutes	8	34.8	1	3.4	0.010 [b]
	20Minutes < ROSC ≤ 24 hours	3	13.0	8	27.6	
	ROSC > 24 hours	12	52.2	20	69.0	
PCI Rate	Yes	5	33.3	7	25	0.561[a]
	No	10	66.7	21	75	
Survival	Yes	13	56.5	21	72.4	0.232 [a]
	No	10	43.5	8	27.6	
Outcomes	Normal life	6	40.0	11	39.3	0.797 [a]
	Brain complications according to CPC criteria	6	40.0	9	32.1	
	Heart Failure	3	20.0	8	28.6	
CPR Complications	Yes	3	20.0	4	14.3	0.680 [b]
	No	12	80.0	24	85.7	

[a]Chi-square Test; [b] Fisher's exact test

after following the T-CPR protocol by bystanders, having been consistent with the results of the present study. According to the study by Bobrow *et al*., [12], after the implementation of the T-CPR program, the patients' survival rate and functional outcomes increased in cases of OHCA, having been consistent with the results of the present study. Based on the results of the aforementioned study, the time to start the first chest compression decreased after the implementation of the T-CPR program, with this having been one of the issues not considered in the present study, so it is recommended to be considered in future ones.

According to the results of the study by Bobrow *et al*., [15], chest-compression-only CPR performed by bystanders led to an increase in the survival rate of the patients with OHCA from 3.7% to 9.8%, having been consistent with the results of the present study. These results can be justified by asserting that T-CPR training could be effective in the faster initiation of chest compression by bystanders and useful in completing the patient's chain of survival until professional personnel reach the patient's bedside. The results of the study by Spelten *et al*., [8] showed that chest-compression-only CPR via telephone guidance by the dispatcher had a significant effect on the effective massage, having been consistent with the results of the present study. Conducting the study on mannequins is the point of difference between the aforementioned study and the present one. However, contrary to the results of the present study and the ones mentioned above, the results of the study by Hagihara et al., [16] showed that the patient's survival rate would be lower when bystanders performed CPR with the guidance and assistance of the dispatcher than the time when they did it without such guidance and assistance. The low quality of CPR is assumed to be the major reason for this result. Therefore, more studies are required in this field to further investigate the results and outcomes.

Considering CPR-related complications, such as rib fracture or the unpleasant feeling felt in the chest, the results of the present study showed that 20% and 14.3% of the patients suffered from a complication before and after the implementation of the T-CPR program, respectively, with no statistically significant difference observed between the two time periods in terms of this outcome. Similarly, the results of the study by White *et al*., [17]) showed that 12%, 2%, and 2% of the patients who received chest compression by bystanders under the dispatcher's guidance experienced an unpleasant feeling, minor injuries, and rib fracture; however, none of them complained of visceral injuries. Therefore, it can be concluded that the number and severity of injuries caused by T-CPR are negligible compared with its benefits, and that increasing the survival rate in patients with OHCA is possible by developing T-CPR programs.

The results of the present study showed that 89% and 95.6% of the bystanders had not received any education or training before and after the implementation of the T-CPR program, respectively. However, according to the results of the study by Kim *et al*., [18], the bystanders who had already participated in CPR training programs had by far lower interruptions than the ones who performed CPR over the phone. Although the above-mentioned study was done on mannequins, it emphasized the positive impact of general trainings in CPR principles and first aid; hence, it is necessary to be included in the programs run by the government and the Ministry of Health of various countries, especially Iran, since special measures have not been adopted in Iran as yet. According to the results of the study by Dianati *et al*., [6], from among 277 bystanders of patients with OHCA, only 10 bystanders (3.6%) performed CPR, and there were 2 cases of the return of spontaneous circulation (ROSC) from the 10 CPR cases performed by the bystanders, with one individual discharged successfully from the hospital. Therefore, it can be concluded that the survival rate will increase in patients with OHCA if necessary training programs, including the T-CPR program, are run at the public level.

The results of the present study revealed that OHCA cases occurred at home in most cases, with cardiovascular factors having been the major causes of OHCA in both pre- and post-T-CPR programs. Likewise, the results of the study by Luc *et al*., [19] showed that over 75% of OHCA cases occurred at home, with cardiovascular factors accounting for half of the cases occurred, having been consistent with the results of the present study. Therefore, by providing family members as well as children at kindergartens and schools with proper trainings in CPR principles, performing CPR by bystanders, and following T-CPR recommendations of dispatchers, the success of the CPR process would become possible.

The results also showed that nearly half of the calls were made from 18:00 p.m. to 6:00 a.m., which were considered as off-hours. In the same vein, the results of the study by Karam *et al*., [20] indicated that during off-hours the survival rate was by 30% less than that of the active hours, having been due to the difference in the primary management of CPR (i.e., the use of trained non-professionals and the automated external defibrillator (AED)); hence, they emphasized the need for active trained non-professionals for 24 hours a day. Given that AEDs are not yet utilized by non-professional people in Iran, they are suggested to be included in the emergency programs of the country, and that such devices be used in CPR training programs. To support this suggestion, according to the results of the study by Capucci *et al*., [21], the use of AEDs increases the survival rate from two to three times in patients with OHCA.

The results of the current study can help healthcare professionals, especially emergency personnel and dispatchers, get more familiar with the subject and develop operational strategies so as to increase the

success rate of this program. Since this study is the first one conducted in Iran on this particular subject, it can be utilized as a guide to emergency personnel and managers as well as authorities in the health sector. Hence, it paves the way for further studies on this subject.

We note some limitations to our study. The use of the pre- and post-intervention design was one of the limitations of the present study, and there was no possibility of doing it as a clinical trial. The lack of full control over confounding variables, such as unknown risk factors that could affect outcomes was another limitation of the present study. It is recommended that similar studies be done in this area with an emphasis on the feasibility of the T-CPR program. The arrival time of the ambulance and the EMT team was another issue not considered in the present study; thus, it is recommended to be considered in future ones. Conducting qualitative studies based on the experience of dispatchers and bystanders is another suggestion for identifying obstacles present in executing this program and providing solutions for facilitating it.

In conclusion, after the implementing of T-CPR program, number of successful CPR cases and survival rate increased, brain complications and CPR-related complications decreased. All results were clinically significant, reflecting the positive effects of the implementation of the T-CPR program on CPR outcomes.

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