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Comparison of three methods of cardiopulmonary resuscitation training in terms of improving the skills of emergency medical technicians; a pretest–posttest study

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Abstract: **Objective:** There are several methods for teaching emergency medical technicians (EMTs) cardiopulmonary resuscitation (CPR); but choosing the most effective option depends on several factors. This study was designed to compare the effectiveness of three different CPR training methods, including traditional, peer, and virtual methods, for EMTs.

Methods: This study was a pretest-posttest study, which was performed from March to September 2020 in Tehran, Iran. Participants were EMTs working in the operations department of the EMS center. In the first step, for the pretest evaluation, an Objective Structured Clinical Evaluation (OSCE) exam was held for all participants. Thereafter, the subjects were divided into 3 groups including master-centered traditional collective education, peer training, and virtual courses. Then the participants underwent educational intervention and after that, another OSCE exam was held about 1 week after the sessions to evaluate the effect of interventions.

Results: At first, 156 volunteers entered the study and participated in the pretest OSCE exam, of which 125 volunteers participated in the posttest OSCE exam. Of these, 51 volunteers participated in the peer education group, 35 volunteers were in the virtual education group, and 39 volunteers in the classic education group. The mean score of the participants in all 4 assessed skills, including endotracheal intubation, laryngeal mask airway insertion, basic life support, and advanced life support, increased significantly after educational intervention in all 3 groups ($p<0.05$); and this increase was higher in the virtual group compared to the other two groups ($p<0.05$).

Conclusion: We found that virtual training was more effective than classic and peer training for CPR training of EMTs.

Keywords: Cardiopulmonary Resuscitation; Emergency Medical Services: Emergency Medical Technicians; Teaching

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1. Introduction

Out-of-hospital cardiac arrest (OHCA) is one of the leading causes of death and disability worldwide and accounts for 10% of all deaths in developing countries (1, 2). Cardiopulmonary resuscitation (CPR) remains the solitary most practical emergency management choice for patients with cardiac arrest (3). During the past decades, the emphasis on optimizing and improving CPR training has significantly been taken into account by governmental health officials in various countries (4). Advances in methods, medication, and skills have been made in performing cardiopulmonary resuscitation (5). In order to increase the likelihood that a person with cardiac arrest receives timely CPR, it is necessary to increase the number of people being trained in this area (6, 7). The aim of emergency medical services (EMS) is to save lives and decrease disability and death (8). Emergency medical technicians (EMTs) are among those who face a significant number of patients with cardiac arrest; therefore, they need special training in this regard. EMTs classically pass basic and advanced CPR courses and have to retrain these courses every 12-24 months (7, 9-11). There are several methods

for teaching CPR such as lectures, role-playing, discussions, workshops, multimedia software, movie screenings, books, etc., but choosing the most effective option depends on several factors. The structure of the EMS and qualification of EMTs in various countries are different; so, the same training method may not have the same efficacy in different systems. The Tehran EMS center intends to revise its CPR training courses and on the first step decided to find out the most proper training method. To the best of our knowledge, there is not any research on this area in the Tehran pre-hospital system. So, this study was designed to compare the effectiveness of three different CPR training methods, including traditional, peer, and virtual methods, for EMTs.

2. Methods

2.1. Study design

This study was a pretest-posttest study, which was performed from March to September 2020 in Tehran, Iran. The required permissions for conducting this study were received from the Tehran EMS center and ethical committee of Tehran University of Medical Sciences (code: IR.TUMS.CHMC.REC.1399.004). All data were recorded, analyzed, and presented anonymously. Participation was completely voluntary without any obligation.

2.2. Participants

Participants were a number of EMTs working in the operations department of the EMS center in Tehran. The required sample size was calculated assuming that all the educational groups have equal performance scores before the courses, and that after the training courses the performance score of participants in the group using the best educational method reaches 100%, and will be at least 20% more than the other two groups (performance score of 80% in the other two groups). Therefore, considering 95% confidence interval and 80% study power, the minimum sample size required to show the difference between the two groups was 44 for each group. Assuming at least 20% precipitation in each group for the post-intervention test, the minimum sample size required in each group was 53 and therefore initially a total of 160 volunteers were included in the study.

2.3. Assessment method

In the first step, for the pretest evaluation, an Objective Structured Clinical Evaluation (OSCE) test was held for all participants. Then participants underwent educational intervention and after these interventions, another OSCE exam was held about 1 week after the sessions to evaluate the effect of interventions and their skills were assessed. To assess Basic Life Support (BLS) and Advanced Cardiac Life Support (ACLS) skills, the American Heart Association (AHA) checklist was used, which contains 15 items for BLS and 21 items for ACLS, and to evaluate Intubation and Laryngeal Mask Airway (LMA), an expert-made checklist was used, which contained 18 items for LMA and 25 items for endotracheal intubation (ETI). The scoring system in this method was to assign a score of 1 if the EMT correctly performed the skill and zero score if not, and to calculate the score for each skill, the total score was divided into the number of items in each station.

2.4. Intervention

The subjects were randomly (Random blocks table) divided into 3 groups of 53 individuals: 1) Traditional (classic) teacher-centered education consisting of 8 hours of theoretical and practical teaching in a day; 2) Peer training consisting of an 8-hour training course, the participants of this group were asked to select volunteers among themselves for resuscitation training and the rest of the volunteers cooperated in holding the course, 3) Virtual courses consisting of 8 hours of theoretical and practical virtual training, which contained a video recording of the classic courses; the participants could watch the film at any time, whenever they wished. Participants and training groups were kept unaware of the goals and opportunities of the study (open-label blinding).

In our study, the face and content validity of the tools were studied with the cooperation of 10 expert individuals and 10 participants. In the evaluation of content validity; tools, transparency, appropriateness, and comprehensiveness of the tools were examined. Finally, content validity indicators were presented for the appropriateness and transparency of each question (Item Content Validity Index: I-CVI) and appropriateness, transparency, and overall comprehensiveness of the tool (Scale Content Validity Index: S-CVI).

2.5. Statistical analysis

The results of descriptive analysis of data were presented using central indicators (such as mean and median) and dispersion indices (such as standard deviation and mid-quarter amplitude) according to the nature of the data. Appropriate parametric and non-parametric tests were used to analyze the data based on the normality assumption. Analysis of variance (ANOVA) test was used to compare quantitative variables in different educational groups. Paired t-test was used to compare the test scores before and after the intervention. To evaluate the effect of the intervention in the groups, the mean score difference before and after the intervention was tested using the one-way analysis of variance. In all analytical analyzes, the p-value <0.05 was considered as the indicator of a significant difference. Data were analyzed using STATA software version 14.

3. Results

In the first stage, 156 cases entered the study took the first exam, of which 125 participated in the study in the post-intervention stage and took the second test. Of these, 51 participated in the peer education group, 35 in the virtual education group, and 39 in the classic education group. The age of study participants ranged from 31 to 54 years. The participants' average work experience in Tehran emergency was

Table 1 Comparison of demographic and basic characteristics of emergency medical technicians of Tehran Emergency Center, participating in training groups with different methods of cardiopulmonary resuscitation training

Variables	Total	Educational groups			P
		Peer	Virtual	Classic	
Gender		Number (percentage) / mean (SD)			
Male	123 (98.4)	51 (100)	35 (100)	37 (94.9)	0.172
Female	2 (1.6)	0 (0.0)	0 (0.0)	2 (5.1)	
Age	35.49 (7.82)	32.37(7.75)	37.63 (6.91)	37.64 (7.45)	0.001
Marital Status					
Single	44 (35.5)	30(60.0)	5(14.3)	9(23.1)	<0.001
Married	80 (64.5)	20(40.0)	30(85.7)	30(76.9)	
Child number	1.59 (0.73)	1.57(0.65)	1.50(0.72)	1.69(0.79)	0.649
Education status					
High school diploma	2 (1.6)	0 (0.0)	1 (2.9)	1 (2.6)	<0.001
Associate degree	58 (46.8)	36 (72.0)	9 (25.7)	13 (33.3)	
Master of science	60 (48.4)	12(24.0)	24(68.6)	24(61.5)	
Master of arts	4 (3.2)	2 (4.0)	1 (2.9)	1 (2.6)	
Studied discipline					
Medical emergency	78 (63.4)	43 (86.0)	19 (54.3)	16 (42.1) *	<0.001
Nursing	25 (20.3)	7(14.0)	6(17.1)	12(31.6)	
Anesthesia	20 (16.3)	0(0.0)	10(28.6)	10(26.3)	
Emergency work experience (year)	10.22 (6.86)	6.31 (5.31)	12.92 (6.26)	12.92 (6.83)	<0.001

*One-person study rescuing.

Table 2 Distribution of test scores before and after the intervention in different educational groups and comparison of differences

Test	Educational group	Mean (SD) total score			Before & after differences
		Before intervention	After intervention	P-Value	Mean (SD)
ETI	Peer	10.35(4.06)	13.86(3.79)	<0.001	3.51(3.65)
	Virtual	14.80(3.17)	19.37(3.05)	<0.001	4.57(4.05)
	Classic	14.0(2.95)	17.18(3.63)	<0.001	3.18(3.56)
	P-value	<0.001	<0.001	-	0.252
LMA	Peer	10.82(3.52)	7 14.64(2.49)	<0.001	3.82(3.45)
	Virtual	9.03(3.85)	13.91(2.43)	<0.001	4.89(4.0)
	Classic	10.79(3.64)	13.64(2.38)	<0.001	2.85(3.20)
	P-value	0.053	0.131	-	0.050
BLS	Peer	13.47(1.32)	14.69(0.62)	<0.001	1.22(1.33)
	Virtual	13.71(1.40)	14.34(0.94)	0.012	0.63(1.39)
	Classic	14.18(0.88)	14.26(0.91)	0.712	0.08 (1.28)
	P-value	0.089	0.659	-	<0.001
ACLS	Peer	12.10(3.16)	14.59(2.92)	<0.001	2.49(2.67)
	Virtual	9.20(3.50)	15.94(2.90)	0.021	6.74(3.57)
	Classic	8.36(3.33)	14.54(2.85)	0.039	6.18(3.59)
	P-value	<0.001	0.061	-	<0.001

ETI: Endotracheal Intubation, LMA: Laryngeal Mask Airway, BLS: Basic Life Support, ACLS: Advanced Cardiac Life Support

10.22 years (SD=6.86).

The level of education in the studied groups was significantly different; the percentage of the participants with an associate degree in the peer group was higher than that of the other two groups. In terms of field of study, the majority of participants (about 60%) studied to become an EMT. However, the studied discipline was significantly different in the studied groups, the percentage of participants graduating in medical emergencies in the peer group was higher than that of the other two groups.

The distribution of the number of correct answers to the 25 questions of the ETI before the educational intervention in the peer group was less than that of the other two groups. Most volunteers in the peer group answered 5 to 15 questions correctly, while in the 2 other groups, the majority of volunteers answered 10 to 20 questions correctly. At last, in all three groups, the ETI test scores were improved after the intervention. The distribution of the number of correct answers to the 18 questions of the LMA before the intervention in the different studied groups was almost identical and most of them answered 4 to 16 questions correctly. This distribution was increased after the intervention in all three groups, and all participants answered more than 8 questions correctly, and the scores were improved in all groups but were improved more in the virtual group compared to the other groups. The distribution of the number of correct answers to the 15 questions of the BLS test before the intervention in the different studied groups was more than 10. In the peer and virtual ed-

Table 3 Distribution of scores in different areas of tests before and after the intervention in different educational groups and comparison of differences

	Scopes of test	Educational group	1^{st} – 2^{nd}-3^{rd} quarter		Mean (SD) of total score			Before & after differences
			Before intervention	After intervention	Before intervention	After intervention	P-Value	Mean (SD)
ETI	Preparation	Peer	2.0-2.0-4.0	4.0-5.0-5.0	2.65(1.49)	4.55(1.15)	<0.001	1.90(1.56)
		Virtual	4.0-5.0-6.0	5.0-7.0-8.0	5.14(1.42)	6.69(1.81)	<0.001	1.54(1.97)
		Classic	4.0-4.0-5.0	4.0-6.0-7.0	4.44(1.33)	5.18(1.92)	0.028	0.74(2.03)
		P-value	-	-	<0.001	<0.001	-	0.014
	Pre-oxygenation	Peer	2.0-3.0-5.0	3.0-4.0-6.0	3.31(1.84)	4.37(1.99)	<0.001	1.06(2.01)
		Virtual	3.0-5.0-6.0	7.0-7.0-8.0	4.66(1.92)	7.09(0.98)	<0.001	2.43(2.00)
		Classic	4.0-5.0-6.0	6.0-7.0-8.0	5.08(1.75)	6.43(1.59)	<0.001	1.36(1.97)
		P-value	-	-	<0.001	<0.001	-	0.007
	Position and Placement	Peer	2.0-3.0-3.0	2.0-3.0-3.0	2.31(0.99)	2.45(1.01)	0.391	0.14(1.13)
		Virtual	3.0-3.0-3.0	3.0-3.0-3.0	2.69(0.83)	2.80(0.47)	0.501	0.11(0.99)
		Classic	2.0-3.0-3.0	3.0-3.0-3.0	2.56(0.79)	3.00(0.76)	0.003	0.44(0.85)
		P-value	-	-	0.141	0.006	0.291	
	Post-intubation management	Peer	1.0-3.0-3.0	2.0-3.0-3.0	2.08(1.18)	2.49(0.92)	0.020	0.41(1.22)
		Virtual	2.0-2.0-3.0	3.0-3.0-3.0	2.31(0.78)	2.80(0.53)	0.001	0.49(0.82)
		Classic	1.0-2.0-3.0	2.0-3.0-3.0	1.92(0.96)	2.56(0.72)	<0.001	0.64(0.87)
		P-value	-	-	0.245	0.178		0.567
LMA	Preparation	Peer	0.0-1.0-2.0	2.0-3.0-3.0	1.25(0.93)	2.37(0.77)	<0.001	1.12(1.05)
		Virtual	0.0-1.0-1.0	2.0-2.0-3.0	0.89(0.93)	2.23(0.77)	<0.001	1.34(0.94)
		Classic	0.0-1.0-2.0	1.0-2.0-2.0	0.85(0.87)	1.82(0.79)	<0.001	0.97(1.13)
		P-value	-	-	0.068	0.004		0.319
	Pre-oxygenation	Peer	2.0-4.0-6.0	4.0-6.0-7.0	3.88(2.01)	5.20(1.71)	<0.001	1.31(2.16)
		Virtual	2.0-3.0-5.0	3.0-4.0-6.0	3.06(2.13)	4.46(1.99)	0.004	1.40(2.67)
		Classic	2.0-4.0-6.0	4.0-5.0-7.0	3.87(2.09)	5.31(1.52)	<0.001	1.44(2.05)
		P-value	-	-	0.142 0.076		0.966	
	Position and Placement	Peer	3.0-4.0-5.0	5.0-5.0-6.0	3.96(1.61)	5.16(0.81)	<0.001	1.20(1.43)
		Virtual	3.0-4.0-5.0	5.0-5.0-6.0	3.77(1.50)	5.23(0.97)	<0.001	1.46(1.67)
		Classic	4.0-5.0-5.0	4.0-5.0-6.0	4.51(1.25)	4.87(1.06)	0.128	0.36(1/44)
		P-value	-	-	0.078	0.213		0.005
	Post-intubation management	Peer	2.0-2.0-2.0	2.0-2.0-2.0	1.72(0.57)	1.92(0.27)	0.011	0.20(0.53)
		Virtual	1.0-2.0-2.0	2.0-2.0-2.0	1.31(0.80)	2.0(0.0)	<0.001	0.69(0.80)
		Classic	1.0-2.0-2.0	1.0-2.0-2.0	1.56(0.72)	1.64(0.58)	0.539	0.08(0.77)
		P-value	-	-	0.027	<0.001		0.001
BLS	Assessment and Activation	Peer	3.0-3.0-4.0	4.0-4.0-4.0	3.33(0.68)	3.88(0.32)	<0.001	0.55(0.76)
		Virtual	3.0-4.0-4.0	3.0-4.0-4.0	3.71(0.52)	3.63(0.60)	0.447	-0.09(0.66)
		Classic	4.0-4.0-4.0	3.0-3.0-3.0	3.79(0.41)	2.95(0.72)	<0.001	-0.85(0.84)
		P-value	-	-	<0.001	<0.001		<0.001
	Cycle 1 of CPR	Peer	2.0-2.0-2.0	2.0-2.0-2.0	1.82(0.38)	2.00(0.00)	0.002	0.18(0.38)
		Virtual	1.0-2.0-2.0	2.0-2.0-2.0	1.69(0.53)	1.97(0.17)	0.003	0.29(0.52)
		Classic	2.0-2.0-2.0	2.0-2.0-2.0	1.82(0.39)	1.87(0.41)	0.571	0.05(0.57)
		P-value	-	-	0.300	0.045		0.125
	Cycle 2 of CPR	Peer	2.0-3.0-3.0	3.0-3.0-3.0	2.53(0.70)	2.86(0.35)	0.003	0.33(0.77)
		Virtual	3.0-3.0-3.0	3.0-3.0-3.0	2.83(0.38)	2.83(0.45)	1.00	0.0(0.64)
		Classic	3.0-3.0-3.0	3.0-3.0-3.0	2.92(0.35)	2.97(0.16)	0.421	0.05(0.39)
		P-value	-	-	0.002	0.147		0.031
	AED	Peer	5.0-5.0-5.0	5.0-5.0-5.0	4.90(0.30)	4.98(0.14)	0.103	0.08(0.34)
		Virtual	5.0-5.0-5.0	5.0-5.0-5.0	4.74(0.78)	4.91(0.28)	0.229	0.17(0.82)
		Classic	5.0-5.0-5.0	3.0-4.0-4.0	4.85(0.36)	3.54(1.02)	<0.001	1.31(1.15)
		P-value	-	-	0.349	<0.001		<0.001
	Resume compression	Peer	1.0-1.0-1.0	1.0-1.0-1.0	0.88(0.32)	0.96(0.20)	0.044	0.08(0.27)
		Virtual	0.0-1.0-1.0	1.0-1.0-1.0	0.74(0.44)	1.00(0.0)	0.002	0.26(0.44)
		Classic	1.0-1.0-1.0	1.0-1.0-1.0	0.85(0.36)	0.95(0.22)	0.160	0.10(0.45)
		P-value	-	-	0.231	0.431		0.089

Table 3 Distribution of scores in different areas of tests before and after the intervention in different educational groups and comparison of differences

	Scopes of test	Educational group	1^{st} – 2^{nd}-3^{rd} quarter		Mean (SD) of total score			Before & after differences
			Before intervention	After intervention	Before intervention	After intervention	P-Value	Mean (SD)
ACLS	Team leader	Peer	0.0-0.0-0.0	0.0-0.0-1.0	0.20(0.66)	0,53(1.03)	0.008	0.33(0.86)
		Virtual	0.0-0.0-1.0	1.0-2.0-3.0	0.26(0.44)	2.17(0.95)	<0.001	1.91(0.98)
		Classic	0.0-0.0-0.0	1.0-1.0-3.0	0.18(0.39)	1.61(0.96)	<0.001	1.44(0.94)
		P-value	-	-	0.804	<0.001		<0.001
	Tachycardia management	Peer	1.0-2.0-4.0	2.0-4.0-5.0	2.67(1.46)	3.63(1/25)	<0.001	0.96(1.43)
		Virtual	2.0-3.0-4.0	2.0-3.0-4.0	3.11(0.99)	3.26(1.15)	0.530	0.14(1.33)
		Classic	2.0-3.0-3.0	3.0-4.0-4.0	2.82(0.99)	3.46(1.31)	0.014	0.64(1.55)
		P-value	-	-	0.244	0.400		0.038
	VF management	Peer	5.0-5.0-6.0	6.0-6.0-6.0	5.25(0.87)	5.65(0.84)	0.004	0.39(0.94)
		Virtual	2.0-4.0-5.0	5.0-5.0-6.0	3.77(1.46)	5.14(0.91)	<0.001	1.37(1.65)
		Classic	3.0-4.0-5.0	5.0-6.0-6.0	3.67(1.42)	5.33(0.84)	<0.001	1.67(1.67)
		P-value	-	-	<0.001	0.026		<0.001
	PEA management	Peer	2.0-3.0-3.0	3.0-3.0-3.0	2.51(0.99)	2.96(0.66)	0.002	0.45(0.99)
		Virtual	0.0-1.0-3.0	2.0-3.0-3.0	1.51(1.40)	2.60(0.85)	<0.001	1.09(1.29)
		Classic	0.0-1.0-2.0	2.0-3.0-3.0	1.20(1.15)	2.56(0.85)	<0.001	1.36(1.25)
		P-value	-	-	<0.001	0.030		0.001
	Post cardiac arrest care	Peer	1.0-2.0-2.0	2.0-2.0-2.0	1.47(0.86)	1.82(0.62)	0.008	0.35(0.91)
		Virtual	0.0-1.0-1.0	3.0-3.0-3.0	0.54(0.50)	2.77(0.55)	<0.001	2.23(0.81)
		Classic	0.0-0.0-1.0	1.0-2.0-2.0	0.49(0.51)	1.56(0.75)	<0.001	1.08(0.87)
		P-value	-	-	<0.001	<0.001		<0.001

ETI: Endotracheal Intubation, LMA: Laryngeal Mask Airway, BLS: Basic Life Support, ACLS: Advanced Cardiac Life Support; CPR: cardiopulmonary resuscitation; AED: automated external defibrillator; VF: ventricular fibrillation; PEA: Pulseless electrical activity.

Table 4 Total scores before and after the intervention in different educational groups and comparison of before and after differences

Educational groups	Mean (SD) total score			Before and after differences
	Before intervention	After intervention	P-Value	Mean (SD)
Peer	46.74 (8.00)	57.78 (7.48)	<0.001	11.04 (5.80)
Virtual	46.74 (8.56)	63.57 (5.99)	<0.001	16.83 (8.46)
Classic	47.33 (6.74)	59.61 (6.72)	<0.001	12.28 (5.86)
P-value	0.926	0.001	-	<0.001
Total	46.93 (7.74)	59.98 (7.21)	<0.001	13.05 (7.04)

ucation groups, the BLS test scores increased after the intervention, which was greater for the peer group, but no significant changes were seen in the classic education group. Regarding the distribution of the number of correct answers to the 21 questions in the ACLS test before the intervention in the different studied groups, most participants answered 5 to 15 questions correctly. Although the intervention increased the test scores in all 3 groups, this increase was more in the virtual and classic groups than in the peer group.

The ETI test had 4 domains and the scores had increased after the intervention in all 3 groups. However, this increase was greater for the "Preparation" and "Pre-oxygenation" domain; also, the increase in the peer group was more than in the other two groups. The scores of the 4 domains in the LMA test were increased after the intervention in all 3 groups. Among them, the increase in the score of "Position" and "Placement", and "Post intubation management" were significant after the intervention and the increase in the virtual group's score was more than that of the other two groups (peer and classic) in both areas. Among the 5 areas of the BLS test, the score increase was seen in the "Assessment and Activation", "Cycle 2 of CPR", and "automated external defibrillator (AED)" after the intervention, which were significant, and the increase in the scores of the peer group in both areas of "Assessment and Activation" and "Cycle 2 of CPR" was more than that of the other two groups (virtual and classic). Also, the increase in scores in the virtual group in the field of "AED" was more than in the other two groups (peer and classic). In the ACLS with 5 domains, the scores increased after the intervention in all domains and all 3 groups. The score increase after the intervention in the 3 groups was significant in all areas.

Although the virtual group showed a higher score than the

other two groups in the areas of "Team Leader" and "Post Cardiac Arrest Care", in the areas of "ventricular fibrillation (VF) Management" and "Pulseless electrical activity (PEA) Management" the classic group had a higher score than the other two groups and in the field of "Tachycardia Management", the Peer group showed better performance.

We found that, out of the 79 questions related to 4 general areas, at least 29 and at most 66 questions were answered correctly before the intervention, which was increased to at least 38 and at most 75 questions after the intervention. The mean total score (correct answers) for all subjects was 46.93 out of 79 questions before the intervention. The mean total score before the intervention was not significantly different in the groups. Although in all 3 groups, the mean total score increased significantly, this increase was significantly higher in the virtual group than in the peer and classic groups. No significant correlation was found between the increase in the total score (before and after the intervention) with the self-efficacy score ($r = -0.099$, $p = 0.273$) and with work experience ($r = 0.170$, $p = 0.058$). However, a weak and inverse correlation was found between self-efficacy score and work experience ($r = -0.204$, $p = 0.022$).

4. Discussion

In this study, we found that all types of teaching courses had a positive effect on the post-test evaluation of the participants, and scores of the post-test evaluation were higher in all parts of our study (ETI, LMA, BLS, ACLS).

In this study, as we described, training courses resulted in an increase in post-test scores in ETI, LMA, BLS, and ACLS; that is consistent with many other studies (6, 7, 12-18). In the ETI test, we found increased post-test scores in all 3 groups of training courses, which is consistent with another study (21); however, there were no significant differences between the classic, virtual, and peer groups. Our study suggests that improved scores in the LMA section of the tests was more noticeable in the virtual group than in the other 2 groups. In the BLS training course, higher scores were gained in the peer and virtual groups compared to the classic group. Since the highest scores were in the peer training group, we hypothesize that the cause might be the easier expression of a peer instructor, and this result is consistent with other studies (6, 7, 13). In general, some studies stated that although classic (traditional) training is the most valuable way of training, virtual training has the same efficacy in CPR courses (19-23).

In ACLS, although all 3 groups showed an increase in the post-test scores, the virtual and classic groups gained higher scores than the peer group, which could be due to the complexity of the process, which needs fluent explanation by instructors; and this is consistent with some studies (4, 18, 24) but not consistent with others (16, 25). In ETI, 4 domains were evaluated, in 3 of which scores had increased after training. The scores in "Preparation" and "Pre-oxygenation" were significantly higher than the other domains, which was more significant in the peer training group. LMA had 4 domains of assessment and 3 domains had increased scores after training, which was significant in "position and placement" and "post-intubation management" and these improvements were found in the virtual group more than the others. Among the 5 areas of the BLS test, the score increase after the intervention was significant in the groups in the areas of "Assessment and Activation", "Cycle 2 of CPR", and "AED" and the score increase in the peer group in both areas of "Assessment and Activation" and "Cycle 2 of CPR" was higher than in the other two groups (virtual and classic). Also, the improved scores of the virtual group in the field of AED was more than that of the other two groups (peer and classic), these findings were consistent with some other studies (6, 7, 12, 13). In the 5 domains of ACLS, the virtual group showed a higher score than in the other two groups in the areas of "Team Leader" and "Post Cardiac Arrest Care", in the areas of "VF Management" and "PEA Management" the classic group had a higher score than the other two groups, and in the field of "Tachycardia Management", the peer group showed better performance, which is consistent with other studies (4, 26).

According to the results, it seems that the items that were more theoretical such as ACLS, and simpler skills such as LMA, had better results with the virtual method, which could be due to the fact that in this study, virtual education was offline and participants could review the educational content several times in their spare time, which was impossible in the classic and peer education. Due to the nature of the work of the operational staff of the Tehran EMS center, where most volunteers have 24-hour shifts, attending classes after shifts, had a significant impact on the amount of learning.

We think that structured and standard resuscitation courses for health care providers can significantly reduce substandard resuscitation as a preventable injury. Organizing and optimizing training programs and selecting appropriate new training methods that coincide with the effectiveness of skills is also vital in terms of knowledge, attitude, and awareness. Also, making these courses and workshops mandatory can be useful in improving the quantity and quality of knowledge and skills of personnel.

5. Limitations

Insufficient cooperation of Tehran EMS technicians to attend workshops and the simultaneity of coronavirus outbreak with workshops and the obligation to follow health protocols and instructions were among the limitations that led to a change in the method of work from 5 methods (peer, virtual, classic, simulation, and training on the bedside) to 3 ways (peer, virtual, and bedside training). Not providing bedside training was another limitation of the present study.

6. Conclusion

We found that virtual training was more effective than classic and peer training for CPR training of EMTs. Self-efficacy and work experience were not related to the effectiveness of

training. A weak and inverse correlation was also found between self-efficacy score and work experience in the current study.

7. Declarations

7.1. Acknowledgement

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7.2. Authors' contribution

The conception and design of the work by all the authors; Data acquisition by SM, PHS, AO, AJ, SA and FM; Analysis and interpretation of data by MR, PS, AJ and SKP; Drafting the work by SM, AO, AJ, SKP and SA; Revising it critically for important intellectual content by MR, PS, PHS and FM; All the authors approved the final version to be published; AND agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work.

7.3. Competing Interests

The authors declare no conflict of interests.

7.4. Funding

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