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RESEARCH ARTICLE

Impact of simulation-based training on basic life support in improving the knowledge and skills of fire and rescue services personnel

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ABSTRACT

Background: Cardiac arrests are life-threatening emergencies where basic life support (BLS) skills involving fast recognition and a skilled response can prevent fatal outcomes. BLS skills are hence very essential for the fire and rescue services (FRS) personnel, who are often called to deal with such emergencies. BLS provides necessary skills to the first responder to treat victims of cardiac arrests, until they can be given full medical care at a hospital simulation-based training for BLS involves "hands-on training" on QCPR manikins. We conducted this study to first know about the existing knowledge and skills of BLS among FRS personnel and then evaluated the effect of simulation-based BLS training in improving knowledge and skills among these personnel by conducting written and practical tests. **Aim and Objective:** The aim of the study was to assess the knowledge and skills of FRS personnel in providing BLS, before and after undergoing the simulation-based BLS training. **Materials and Methods:** A total of 91 FRS male personnel, belonging to cadres of new trainees and officers and of age groups <26 years, 26–32, and >32 years, were included as participants in this experimental study. Each participant underwent a simulation-based "hands-on" BLS training using adult, child and infant QCPR mannikins equipped with feedback devices, Ambu bags, and automated external defibrillator trainers. They were taught the sequence of the steps of BLS on the designated manikins using simulation-based teaching methodology. A self-administered, pre-tested questionnaire was used to evaluate with a pre-test and post-test along with a practical skill assessment. The data were analyzed using the Statistical Package for the Social Sciences version 22.0 – unpaired and paired *t*-test. Institutional ethics committee clearance was obtained for the study. **Results:** Of the total number of 91 participants, 47.3% (43) were less than 26 years of age and 45.1% (41) were between 26 and 32 years of age and 7.7% (7) were more than 32 years of age. About 92.3% (84) of the participants were new trainees and 7.7% (7) were in the officer cadre. Paired *t*-test has been used for the analysis and since $P < 0.001$ is <0.05, there is statistically significant difference between pre-test and post-test scores in all participants. However, there is no significant difference in pre- test/post-test scores between new trainee and officer cadre ($P = 4.471$ and 1.603, respectively). There was no significant difference in pre- and post-test scores with respect to the different age groups of participants. **Conclusion:** Simulation-based training has an impact on the knowledge and skills of FRS personnel in BLS.

KEY WORDS: Basic Life Support; Simulation; Fire; Rescue

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INTRODUCTION

Sudden cardiac arrest cases in the community form an important public health issue are a matter of concern these days. Cardiac arrests are life-threatening emergencies, where fast recognition and a skilled response can prevent fatal outcomes. Basic life support (BLS) involves immediate recognition of the condition, activation of the emergency response system, early cardiopulmonary resuscitation (CPR), and rapid defibrillation.[1] BLS provides necessary skills to the first responder to treat victims of cardiac arrests, until they can be given full medical care at a hospital. BLS comprises initial assessment, high quality CPR with chest compressions, airway maintenance, and early defibrillation. These skills are understandably very essential skills for all first responders and especially the fire and rescue services (FRS) personnel, who are very often first responders and have to deal with such emergencies. Hence, competence in providing BLS and especially early CPR which is critical for saving lives is essential for the FRS personnel. Simulation is an imitation of a situation or process, to create an artificial situation, to study something through experience. Medical simulation is being increasingly used in the recent times as a training tool to improve knowledge and skills related to resuscitation among medical and paramedical fraternity. With this background, we wanted to explore this type of training could be extended to the FRS personnel. Hence, we started with a basic assessment of the existing knowledge and skills of FRS personnel about BLS and then evaluated the impact of simulation-based training in improving the knowledge and skills among these personnel.

MATERIALS AND METHODS

Study Design

This was an experimental study.

Study Area

The study was conducted at the SRM/Stratus Centre for Medical Simulation, SRM Medical College Hospital and Research Centre, Kattankulathur, SRM IST.

Study Period

The study was done over a period of 1 month, in September 2019.

Sample Size

The sample size was 91.

Inclusion Criteria

Personnel belonging to FRS Department of FRS of age groups <26 years, 26–32, and >32 years, of male gender, belonging to cadres of new trainees and officers was included as participants in this study.

Exclusion Criteria

Personnel of FRS Department of FRS belonging to the age group of >40 years and of female gender was not included as participants in this study.

Methodology

A total of 91 participants were included in this study, after obtaining their consent and Institutional Ethical Committee Clearance was obtained. The data were collected from all the participants regarding age and gender and recorded in Microsoft Excel spreadsheet. The study tool which was used was a self-administered pre-tested questionnaire. The simulation equipment used by the participants was simulation mannikins with feedback devices, Ambu bags, disposable mouth pieces, and automated external defibrillator (AED) trainers [Figure 1].

The instructor, at first explained to the participants, a scenario of a cardiac arrest in an adult happening in the community and later demonstrated the steps of adult BLS skills in the appropriate sequence:

1. Check for safety of the scene
2. Assess the victim and activate the emergency response system: Check for responsiveness of the victim by tapping on the shoulders and shouting
3. If there is no response, shouts for help or directs someone close by to call for help and get the AED. If there is no one close by, emergency number can be dialed from mobile on speaker phone to keep hands-free
4. Checks for breathing and pulse: Scans from the head to the chest for breathing for a minimum of 5 s and no more than 10 s. Simultaneously checks for a carotid pulse.
5. If there is no pulse or breathing, initiate compressions within 10 s
6. Perform high quality chest compressions: This includes correct placement of hands in center of chest, compression rate of 100–120/min, deliver 30 compression in 15–18 s, at depth of about 5 cm, allow complete chest recoil after each compression, and minimize interruptions in compressions
7. Delivers two breaths so <10 s elapses between last compression of one cycle and first compression of next cycle

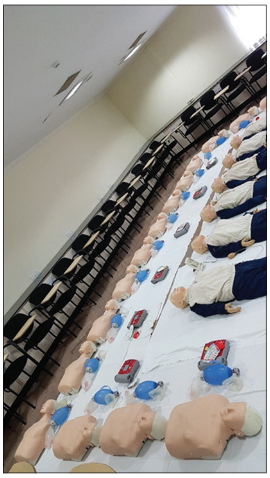

Figure 1: Simulation mannikins with feedback device, Ambu bags, disposable mouth pieces, automated external defibrillator trainers used for basic life support training

8. Provides effective mouth to mouth breathing as a single rescuer or with bag mask device during two rescuer CPR after ensuring head tilt and chin lift
9. Delivers each breath over 1 s to produce visible chest rise. Avoids excessive ventilation
10. Resumes chest compressions in <10 s
11. After five cycles of chest compression and ventilation, compressors switch roles in a two rescuer resuscitation. Switch should take no more than 5 s
12. When the second rescuer arrived and gets AED, the trainer demonstrates how to perform simulated defibrillation by following the instructions in AED trainer device
13. The steps of AED usage are given by audio-prompts by the device – (a) to power on, apply pads on bare chest, (b) attach electrodes, (c) analyzing rhythm during which CPR may be withheld, (d) if shock is advised, charging of AED takes place (e) during the time machine takes to charge, CPR may continue, and (f) shock is delivered by pressing the shock button on the AED trainer, after clearing
14. The instructor checks the carotid pulse of the arrested victim infant and continues until heart rate is regained or emergency response system arrived.

Every participant had "hands-on practice" on the manikins, on every step of BLS [Figure 2a and b]. The instructor concludes the simulation session events by debriefing with the participants. The duration of BLS training, that each participant received was about 8 h. At the end of the session, a post-test was conducted, and scores were given. A practical "hands-on" test based on BLS was also done to evaluate their psychomotor skills in doing the correct sequence of steps in BLS and in operating AED, as a single rescuer and as a 2nd rescuer. Feedback forms were administered.

Statistical Analysis

The entire data were entered into Microsoft Excel and analyzed using SPSS version 22.0. Frequency and percentages among descriptive statistics were used to describe the data and independent and paired *t*-test has been used for the analysis. $P = 0.05$ was considered to be statistically significant. To document the impact of simulation-based teaching among the participant group, the scoring was done, based on the options

Figure 2: (a,b) Fire and rescue service personnel practicing steps of basic life support on manikins

the participant selected for each of the ten pre-test questions [Annexure 1]. Scores ranging from 1 to 4 were given as per Likert scale. For a correct statement, a score of four was given for strongly agree, three for agree, two for neutral, and one for disagree. For example, the question 1: CPR in adult chest compression should be at a depth of 1 ½ inches is wrong and hence if the response was "disagree," it was given a score of 4, followed by "neutral" with a score of 3, "agree" with 2, and "strongly agree" with 1.

RESULTS

The general characteristics of the participants were that total study participants, 100% (91) were males, of which 92.3% (84) were new trainees and 7.7% (7) were in the officer cadre. The age distribution was that 47.3% (43) were <26 years of age and 45.1% (41) were between 26 and 32 years of age and 7.7% (7) were more than 32 years of age [Table 1].

The mean for pre-test score for all participants is 20.1429 and post-test score is 23.9560. The mean for pre-test score for new trainee is 20.5833 and post-test score is 24.0714. The mean for pre-test score for officer is 14.8571 and post-test score is 22.5714 [Table 2].

Paired *t*-test has been used for the analysis and $P = 0.05$ was considered to be statistically significant. Since the ($P < 0.001$) is <0.05, there is statistically significant difference between pre-test and post-test scores in all participants, new trainee, and officer groups [Table 3].

The age wise distribution, the mean for pre-test score for participants <26 years of age was 21.4419 and mean for post-test score 24.3953. The mean for pre-test score for participants between 26 and 32 years of age was 19.6829 and mean for post-test score was 23.7317. The mean for pre-test score for participants more than 32 years of age was 14.8571 and mean for post test score was 22.5714 [Table 4].

Independent *t*-test has been used to test if there is difference in pre-test/post-test scores between new trainee and officer

Table 1: General characteristics of the participants

Variables	Frequency (*n*)	Percentage (%)
Participants		
Male	91	100.0
Cadre		
New trainee	84	92.3
Officer	7	7.7
Age category		
<26 years	43	47.3
26–32 years	41	45.1
>32 years	7	7.7

cadre. There is no significant difference in pre-test/post-test scores in new trainee and officer cadre ($P = 4.471$ and 1.603, respectively) [Table 5]. Hence, all participants, both new trainee and officer cadre, have been shown to have received the same effect when simulation-based teaching was used.

As the hypothesis being tested is "simulation- based training has an effect on the knowledge and skills of participants in Basic Life Support," with the above results, the hypothesis is accepted that simulation-based training has an effect on the knowledge and skills of participants in Basic Life Support."

Table 2: Pre- and post-test mean scores of participants

Participants	Test	*n*	Mean score			
			Minimum	Maximum	Mean	Std. deviation
All participants	Pre_Test	91	10.00	28.00	20.14	3.58
	Post_Test	91	18.00	30.00	23.96	2.40
New trainee	Pre_Test	84	10.00	28.00	20.58	3.28
	Post_Test	84	18.00	30.00	24.07	2.31
Officer	Pre_Test	7	10.00	18.00	14.86	2.97
	Post_Test	7	18.00	26.00	22.57	3.21

Table 3: Comparison of pre- and post-test mean scores of participants

Variables	Mean	*n*	Std. deviation	Std. error mean	*t*-statistic	*P*-value
All participants						
Pre_Test	20.1429	91	3.58259	0.37556	−9.996	<0.001
Post_Test	23.9560	91	2.39867	0.25145		
New Trainee						
Pre_Test	20.5833	84	3.27535	0.35737	−8.967	<0.001
Post_Test	24.0714	84	2.30654	0.25166		
Officer						
Pre_Test	14.8571	7	2.96808	1.12183	−10.8	<0.001
Post_Test	22.5714	7	3.20713	1.21218		

Table 4: Comparison of pre- and post-test mean scores of participants according to age

Variables	Mean	N	Std. deviation	Std. error mean	*t*-statistic	*P*-value
<26 years						
Pre_Test	21.4419	43	3.07294	0.46862	−5.352	<0.001
Post_Test	24.3953	43	2.47020	0.37670		
26–32 years						
Pre_Test	19.6829	41	3.27444	0.51138	−7.485	<0.001
Post_Test	23.7317	41	2.09791	0.32764		
>32 years						
Pre_Test	14.8571	7	2.96808	1.12183	−10.8	<0.001
Post_Test	22.5714	7	3.20713	1.21218		

Table 5: Independent *t*-test

Cadre	*n*	Mean	Std. deviation	Std. error mean	*t*-statistic	*P*-value
Pre_Test						
New trainee	84	20.5833	3.27535	0.35737	4.471	<0.001
Officer	7	14.8571	2.96808	1.12183		
Post_Test						
New trainee	84	24.0714	2.30654	0.25166	1.603	0.112
Officer	7	22.5714	3.20713	1.21218		

DISCUSSION

Our study involved 91 participants who were FRS personnel, of male gender, of age groups <26 years, 26–32, and >32 years, belonging to cadres of new trainees and officers. On analysis of their pre-test and post-test BLS scores along with practical skills, it was found that simulation-based training has an impact on the knowledge and skills of FRS personnel in BLS. It has also proven that the participants belonging to all age groups, between 25 and 35 years and both cadres of new trainees and officers, have received the same impact when simulation-based teaching method was used.

It has been observed in an earlier study that medical training of such fire fighters shows considerable variance and hence a national standard should be established so that all fire fighters acquire a common set of medical competencies. Simulation in medical education has been increasingly to provide a simplified model of clinical practice to aid learning.[2,3] From the previous studies, we have learned that proper education regarding early recognition of cardiac arrest, providing the right steps of BLS, is desired across the entire world.[4,5] Although the FRS personnel knew that CPR was to be given to a person with a cardiac arrest, the simulation-based training provided them with adequate psychomotor skills to provide high-quality CPR, and the steps to use the AED to provide defibrillation, which are critical concepts emphasized by the American Heart Association. Earlier studies have proven that CPR training increases skills for successful resuscitation rates and better outcomes,[6] which was also seen in the present study. As it was proven in the previous studies that meeting the compression rate improves survival following resuscitation,[7] it was found that the participants in our study met the desired compression rate during the course of our present simulation-based BLS training. It was also observed in few studies that the number of chest compressions delivered per minute is an important determinant of return of spontaneous circulation and neurologically intact survival.[8,9] and defibrillation when given during the first 3–5 min during resuscitation can produce survival rates as high as 50–70%.[10] These critical parameters were met in the present study, because of the QCPR mannequins used during the training, which provided feedback about the CPR parameters, leading to vast improvement in CPR skills when compared with no feedback as also was concluded in an earlier studies.[11,12]

Preparation through education is less costly than learning through tragedy[13] and this is especially true with respect to providing BLS in out of hospital cardiac arrests. Simulation-based training gives the FRS personnel the right mix of knowledge, skills, and confidence to provide the best care for cardiac arrests, which is the strength of the study. The limitations of the present study similar to the earlier published studies are that there may be differences in methodology used by different instructors which can have an effect on the optimal learning experience of the participant. There is also possibility of skill decay that can occur over a period of time, if the skills learnt are not regularly put to use, which can be overcome by such periodic training. Further studies, after a period of time are required to document the retention of the knowledge and skills of the participants.

CONCLUSION

Based on the findings of the current study, it can be concluded that simulation-based training on BLS had a positive impact on improving the knowledge and skills of the personnel of FRS so that they can confidently resuscitate a victim with cardiac arrest, they may encounter anytime, in the community.

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