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Is There an Improvement in Patient Survival/Code Blue Activation after Training Based on Simulation (Basic Life Support—BLS) Based Practice of Cardiopulmonary Resuscitation?

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Abstract

Background and Aim: The only way to survive a sudden cardiac arrest is when the CPR is performed immediately after the arrest. The focus of the present research study is to assess the effectiveness of a pre- and post-simulation-based BLS training (BLS) and the outcome was measured on the basis of patient survival after the cardiac arrest. **Study Design**: This pre- and post-training BLS/CPR training study enrolled all nursing staff, all hospital residents, internees, throughout the hospital in a simulation-based BLS training as per the standards of American Heart Association (AHA), to make them respond to immediate resuscitation and code blue activation during the cardiac arrest within the hospital premises including ED, wards, ICUs, MRI, CT and all miscellaneous areas. The providers completed self-efficacy questionnaires as per the AHA protocol before being certified and were evaluated during the emergency in hospital cardiopulmonary arrest. **Results:** 296 nursing staff, 206 non-healthcare professionals, 143 residents, 212 internees, and 98 medical staff grade doctors completed the BLS training (total 955 hospital staff—providers) were graded for the response by pre- and post-training testing. In the course of pre-BLS training period out of the 250 cardiac arrest patients, 68 patients (27.2%) had ROSC, while after instituting the BLS training period, 143 individuals (40.86%) of the 350 patients who had cardiac arrest had ROSC (p <

0.05). **Conclusion:** A simulation-based CPR and BLS training curriculum greatly improves patient outcome by reducing mortality and morbidity with improved subjectivity, self-efficiency along with the objective assessment of the performance scores during acute cardiac arrest in Emergency Cardiovascular Care (ECC).

Keywords

Basic Life Support (BLS), Cardiopulmonary Resuscitation (CPR), Cardiac Arrest, Simulation-Based Training, Curriculum

1. Introduction

Sudden cardiac arrests are prominent public health threats and are the third most commonly attributed cause of mortality cause and disability, following heart disease and cancer [1]. Cardiac arrest could target apparently healthy people of any age, gender, race or ethnicity in either the hospital or out of the hospital at any given point of time mostly without a warning [2]. An individual's pulse disappears in a moment of time due to abrupt loss of heart function resulting in sudden collapse and sudden loss of consciousness, followed by mortality if therapy is not instituted rapidly. However, the heart can be restarted by immediate CPR/Chest compressions after arrest, and then individuals have high chances of making uneventful recovery without any long-term consequences.

The American Heart Association (AHA) recently reported that about 90 per cent of the people suffering a sudden cardiac arrest will die from the incident. Cardiopulmonary Resuscitation (CPR) initiation or Basic Life Support (BLS) could double or even triple overall survival and health outcomes [3] [4]. Survival of a cardiac arrest event is based on prompt identification of the episode and prompt response involving activation of a "*Code blue"* team and initiation of high-quality CPR [3]. Code blue is the term used to denote an emergency medical condition in which the patient does not have a pulse and is struggling to breathe or under cardiac arrest. The AHA (2016) defined a cardiac arrest as sudden loss of cardiac activity in a person who may or may not have any underlying or pre-existing cardiac conditions, and can be terminal if corrective measures are not instituted immediately. In response to a Code blue incident, the term cardiopulmonary resuscitation (CPR) and basic life support (BLS) are often used interchangeably to characterize an emergency procedure executed.

There are some measures that can be carried out by health care professionals and providers which can dramatically increase the recovery rate of the patient suffering from an In Hospital Cardiac Arrest (IHCA). Girotra *et al.* [5] examined more than 100,000 adult patients in more than 500 hospitals and revealed that IHCA recovery was not followed by shorter defibrillation times. This indicated that survival improvements may include increased availability of qualified staff, faster identification of cardiac arrest, quality of chest compression, quality of

acute resuscitation, post-ROSC (Return of Spontaneous Circulation), induced hypothermia or Targeted Temperature Management (TTM), shorter response time, and minimizing chest compression interruptions.

Maintaining adequate BLS skills are crucial to achieving the best probability of revival for those suffering a sudden cardiac arrest event. After the establishment of Rapid Response Teams (RRTs), the number of Code blue events in medical and surgical units across the nations have reduced substantially [6]. Basic life-support skills are renewed every two years using common recommendations and guidelines from the American Heart Association (AHA). Many healthcare staff complete an online section of the course, and afterwards undergo a face-to-face segment where they demonstrate BLS skills on a manikin. Preparation and readiness of the personnel, improving expertise, and safeguarding equipment are benefits according to Hill *et al.* [6] of mock Code blue simulations. The focus of this research is to estimate the effectiveness of a simulation-based CPR training (BLS) and incorporate it into the curriculum in ambulatory ED/Inpatient ICUs and general wards, and the outcome was measured on the basis of patient survival after an event of cardiac arrest.

2. Methods

The research considered all nursing personnel, all hospital residents and interns who were voluntarily and willingly participated in pre- and post-training BLS/CPR training trial in a simulation-based BLS training according to American Heart Association (AHA) standards to allow them to respond to immediate resuscitation and code blue activation during cardiac arrest within the hospital premises including ED, wards, ICUs, MRI and CT. Until being certified, the caregivers completed self-efficacy questionnaires as per the AHA procedure and were tested in cardiopulmonary arrest at the hospital during the emergency. The staff who were unwilling for any reasons were excluded from the study group.

The project was approved by the Institute's ethical committee where we formulated a retrospective analysis regarding determination of the impact of the above-stated intervention on the outcomes of CPR in victims of in hospital cardiac arrest (IHCA). The non-palpable pulse or ventricular fibrillation, asystole, pulseless electrical activity (PEA), or pulseless ventricular tachycardia (VT) was designated as a cardiac arrest.

We reported every single patient of cardiac arrest in-hospital involving adult subjects (>18 years of age) between January 2018 and December 2018 that happened over a 12-month span at a university hospital. Data was gathered from *Code blue running sheets* concerning each cardiac arrest. In the previous year from January 2017 to December 2017, we compared the Code blue data, *i.e.*, pre simulation (BLS) based practice of CPR training duration with post-simulation (BLS) based practice of CPR training period from January to December 2018. Each and every participant was graded into inadequate, moderately adequate and adequate for the response by pre- and post-training testing based on overall

level of knowledge, skill and attitude (KSA).

The study did not include the patients on whom CPR was instituted during pre-hospital arrival period or prior to the entry of patient in the Emergency Department (ED). When a patient suffered recurrent and several episodes of cardiac arrests in hospital, the analysis included only the initial episode of the arrest. The data collection consisted of demographic data for patients and CPR results. In our study CPR was given to patients with cardiac arrest for up to 40 minutes or more when deemed necessary. The findings of concern were prompt revival following CPR and survival to uneventful hospital discharge. Immediate or prompt survival was described as Return of Spontaneous Circulation Patients (ROSC).

The code blue running sheet consisted of a triplicate copy of detailed electronic medical record (EMR) of the incident with proportions of inclusion and missing portions of documentations or incorrect documentations regarding the quality of CPR, defibrillation, intubation, oxygenation and/or ventilation, intravenous line placement, along with administration of drugs/fluids/ rate, electrocardiogram rhythm check and laboratory parameters sent including arterial blood gas (ABG). The first or white copy is retained in the patient's chart, while the second or yellow copy is reviewed by the team leader present during the code blue and the medical audit team including the ICU medical director for debriefing purposes. The pink copy or the third copy is retained in pharmacy for pharmacological audit purposes.

Data Collection and Analysis

In the present study, the investigators collected data on pre & post-test knowledge questionnaire and pre and post skills observed using observation check list, the observations were recorded with the help of the co-ordinators and Planned Training programme was implemented in different divisions.

The pertinent data were processed in the Microsoft Excel folio and analysed using t-test and comparison made regarding immediate survival rate of cardiac arrest (ROSCs) and survival of patients with uneventful hospital discharge levels during the pre-BLS and post-BLS training period. $p < 0.05$ has been taken as significant statistically for all the analyses.

3. Results

296 nursing staff, 206 non-healthcare professionals (attendants, ambulances drivers, cleaners, etc.) 143 resident doctors, 212 internees, and 98 medical staff grade doctors completed the BLS training (Total 955 hospital staff-Providers) were graded for the response by pre- and post-training testing. Figure 1 reveals the overall level of knowledge in the pre-BLS training. 90% staff had inadequate knowledge, 10% staff being medical doctor had a moderately adequate knowledge but not fully adequate knowledge on BLS. The post-BLS training overall level of knowledge showed that 94% had sufficient critical adequate knowledge, 6% had moderate adequate knowledge and none of them had inadequate knowledge.

Table 1 depicts that the overall mean score was 26.33 with S.D 2.56 and post-BLS training mean score was 98.32 with SD of 2.39. The calculated "t" value was 40.36 which was higher than the table value. Subsequently there was a high statistically significant difference linking the pre-BLS training and post-BLS training score among the caregivers of clients at $p < 0.001$ level.

Table 2 depicts that a positive correlation in level of knowledge and cognitive skills in BLS was demonstrated as highly significant at $p < 0.05$ level indicating that increasing the level of knowledge, can increase the level of skills acquired through BLS.

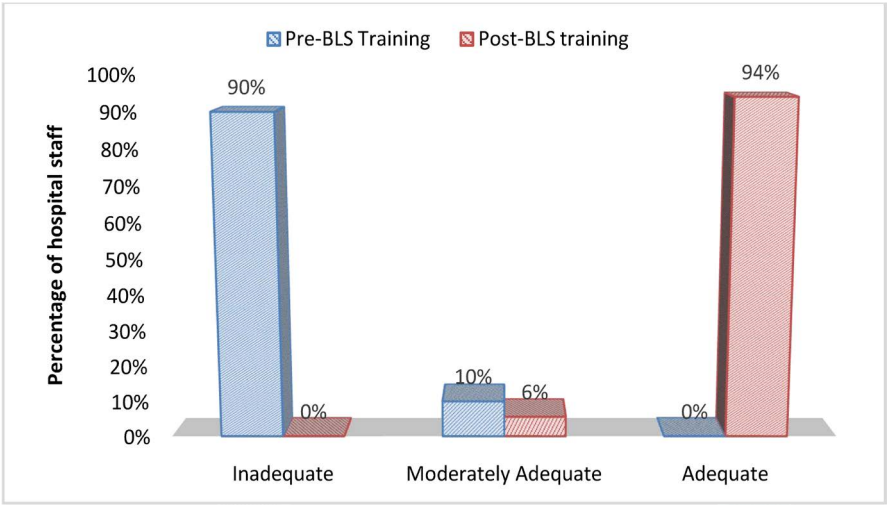

Figure 1. Comparison of overall level of knowledge among the hospital staff in the pre and post BLS training.

Table 1. Comparison between pre and post-BLS test level of knowledge among the healthcare givers (n = 955).

Knowledge	Sample		t value
	Mean	SD	
Pre-BLS training	26.33	2.56	40.36 {S}*
Post-BLS training	98.32	2.39	

***p < 0.001, **p < 0.01, *p < 0.05.

Table 2. Correlation of post-BLS training level of knowledge with the post-BLS training level of skill among the healthcare givers (n = 955).

Variables	Post-BSL training		r value
	Mean	SD	
Level of Knowledge	27.96	2.66	0.86 {S}*
Level of Skill	20.69	1.49	

***p < 0.001, **p < 0.01, *p < 0.05.

During the timeline of pre-BLS training period from January 2017 to December 2017 out of the 250 cardiac arrest patients, 68 patients (27.2%) had revival (ROSC), whereas, in the time period between January 2018 to December 2018 of the post-BLS training period 143 patients (40.86%) of the 350 patients who had cardiac arrest had ROSC ($p < 0.05$).

In our study, there was a marked improvement in survival to uneventful discharge from the hospital rates (30.88% during pre-BLS training versus. 52.45% in the Post-BLS training period) after formal BLS training ($p < 0.05$). Out of the 68 patients who had immediate survival after IHCA during the pre-BLS training period, only 21 patients (30.88%) were uneventfully discharged from the hospital. In contrast, the post-BLS training period revealed that 75 patients (52.45%) had uneventful hospital discharged out of the 143 cardiac arrest patients who had ROSC. In the aftermath of the BLS training time period the survival to uneventful hospital discharge rate was significant statistically ($p < 0.05$) as compared to the no training or pre-BLS training period (Figure 2).

4. Discussion

Total 955 health care professionals (HCPs) were included in the study. Health care providers unbiased objectivity scores of performance showed improvement in all the domains ($p < 0.05$) in situations requiring CPR resuscitation when scores were stratified according to the level of training of HCPs. The staff grade doctor participants demonstrated global improvement to a great extent. The nursing staff had maximum improvement with significant differences between pre and post training, especially self-administration of high quality CPR confidently and activation of Code blue. The least improvement was observed in non-healthcare professionals who were reluctant for fear of legal consequences

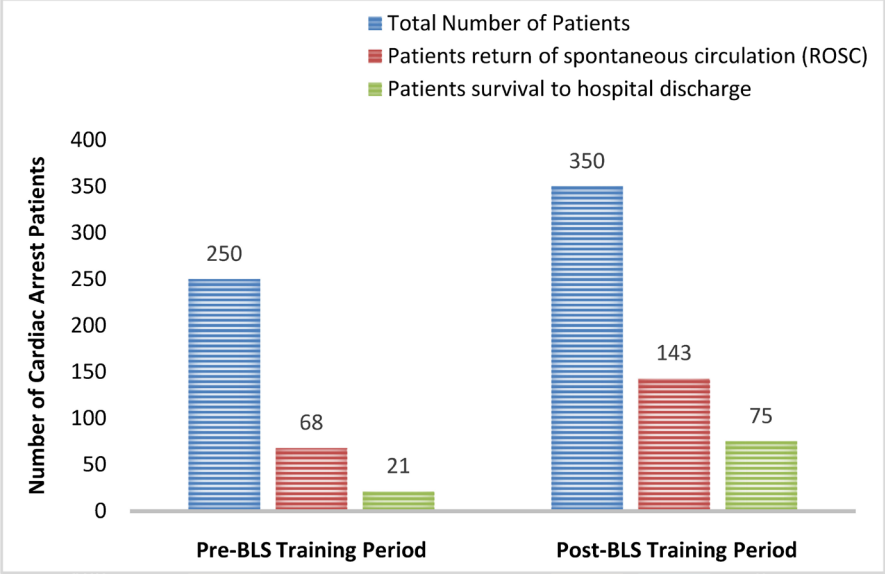

Figure 2. Survival of patients regarding in hospital cardiac arrest (IHCA) during the pre-BLS and the post-BLS training period.

and lack of confidence. When scores were arranged into a strata and classified by earlier simulation experience and participation, HCPs with previous exposure and knowledge of simulation demonstrated improvement in every aspect but delayed the activation of code blue system, which was the probably due to the overconfidence and self-assertiveness of the staff grade providers. The pre-training and post-training self-effectiveness assessment demonstrated improved in the 9 areas were:

1) Initiation/activation of hospital Code blue
2) Administration of immediate CPR
3) Immediate use of defibrillation for shockable rhythms
4) Confidence of the providers during CPR administration
5) Better communication skills during the code of resuscitation
6) Better formulation of team work
7) Better airway management, Bag mask, Intubation
8) ACLS (Advanced Cardiovascular Life Support) management after the code team arrival
9) Self-efficiency analyses after resuscitation exhibited vast advancement and refinement in confidence regarding the management of cardiovascular emergencies (Cardiac arrest in the hospital) and capability to liaise better during the emergency medical situations.

The present research study revealed that during the pre-BLS period the revival from cardiac arrest (ROSC) was 27.2% which increased to 40.86% in the post-BLS period. ROSC proportion during both periods of study were significantly not different from those of previous rates in hospital cardiac arrest (IHCA) studies [7]. Nonetheless, our analysis clearly suggests an enhanced survival rate and achievement of ROSC following the formal BLS teaching, practice sessions and education ($p < 0.05$). Our research also reported significantly improved survival to uneventful discharge from hospital rates (30.88% vs. 52.45%) following academic BLS training ($p < 0.05$). Survival of cardiac arrest to uneventful hospital discharge rates during our study's pre-BLS/ACLS duration is more or less commensurate to that which is recorded in the cardiovascular literature (11.7% - 32.2%), but the substantial improvement in survival to uneventful hospital discharge percentages after the BLS training shows that systematic teaching and training of code blue team members strengthened CPR's expertise and resuscitation skills [8]. This also shows that after the BLS training the efficiency and quality of the CPR performed could be higher. Cardiac arrest in hospital is an emergency condition involving coordination and effective coordinated steps to save the patients. After cardiac arrest with CPR, the success of ROSC depends on timely interventions, especially high quality uninterrupted chest compressions, early defibrillation aided with ventilation. Most changes and developments in the performance of resuscitation have occurred during the last five decades with the institution of present-day CPR [9]. Notwithstanding substantial attempts to upgrade and revamping the management of the cardiac ar-

rest, however, the majority of reports provided for survival outcome are low. Several studies have described that the rate of successful CPR is as low as 2%-6% even in hospitalized patients, despite the fact that the recent data of most of the studies report a fruitful CPR result in the wide proportion of 13% - 59% [10].

It also highlights the significance of outcome of resuscitation following certified simulation-based training programme like the AHA or other equivalent certifications which are more stringent as far as the training guidelines are concerned. Many guidelines have been published on performing CPR and certified accredited training courses established upon the continued improved recommendations have now befitted a quality in the simulation based training of healthcare and medical professionals in almost all the places around the world [11]. These simulation based educative courses aim to pledge the guidance, information and instructions regarding the hands-on practice in peri-arrest situations and the medical management in the manner confirming with the latest medical guidelines. Throughout our research, we found that there was a lack of proper knowledge about CPR among paramedical workers and such training greatly enhances their effectiveness. The inappropriate training and lack of sufficient expertise of the nursing staff, doctors, other HCPs in BLS and ACLS have been described as a major contributor to the inferior end result of the victims of cardiac arrest [12]. Recent studies have concentrated on the quality and timing of CPR to strive and enhance the outcome of cardiac arrest [13]. While the courses related to life-support educational developments are promoted across the globe, little research has been done on their effectiveness as far as the patient outcome is concerned. A few research after the formal resuscitation training are obtainable and accessible in the literature as regard to the systematic observation with respect to the CPR performance. An in-patient analysis found that cardiac arrest identified and diagnosed by a BLS-educated staff was significantly linked with a three-fold increase in survival to uneventful hospital discharge relative to that identified by hospital staff without training [12].

5. Conclusion

A simulation-based CPR and BLS training curriculum greatly improves patient outcome by reducing mortality and morbidity with improved subjectivity; self-efficiency and unbiased objectivity scores of performance showed improvement in all the domains in acute cardiac arrest in Emergency Cardiovascular Care (ECC). We feel that the BLS as well as ACLS training with real time simulation should be implemented in the curriculum very early in the medical school and at all the levels of community (non-health care professionals) to improve patient-related outcome of sudden cardiac arrest. We strongly feel and conclude that the CPR/BLS/ACLS standardized training protocol is an excellent means of communicating the knowledge, attitude and skills via demonstration. Planned focused training and demonstration is therefore a feasible option for enhancing the cardiopulmonary resuscitation (CPR) and expertise in emergency cardi-

ovascular care (ECC) for lifesaving services in the community as a whole.

Ethical Statement

Ethical Approval: All procedures performed in this study were in accordance with the ethical standards of the committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed Consent: Informed necessary consent was obtained from all subjects and participants wherever necessary in the present research.

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Authors' contributions: All the authors had contributed in the process of—

1) Concept and design, acquisition of data and /or analysis and interpretation of data.

2) Drafting the article and/or revising it critically for important intellectual content.

3) Final approval of the version to be published as per uniform requirements for manuscripts submitted to biomedical journals.

4) However, most of the work related to the above was done by author 1 and 2 and hence both authors should be considered as first authors.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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Abbreviations

BLS—Basic Life Support
ACLS—Advanced Cardiovascular Life Support
CPR—Cardiopulmonary Resuscitation
ED—Emergency Department
ICU— Intensive Care Unit
AHA—American Heart Association
ABG—Arterial Blood Gas
EMR—Electronic Medical Records
MRI—Magnetic Radioisotope Imaging
CT—Computed Tomography
ROSC—Return of Spontaneous circulation
ECC—Emergency Cardiovascular Care
IHCA—In Hospital Cardiac Arrest
TTM—Targeted Temperature Management
RRTs—Rapid Response Teams
PEA—Pulseless Electric Activity
VT—Ventricular Tachycardia