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Impact of cardiopulmonary resuscitation duration on functional outcome, level of independence, and survival among patients with in-hospital cardiac arrests: A pilot study

Anandhi D. Amirtharaj, Malarvizhi Suresh[1], Navaneetha Murugesan[2], Mony Kurien[3], Ali H. F. Karnam[4]

College of Nursing, Sultan Qaboos University, Sultanate of Oman, [1]Medical Surgical Nursing, College Of Nursing, P.I.M.S, Kanagachettikulam, Pondicherry, India, [2]Community Health Nursing, College of Nursing, P.I.M.S, Kanagachettikulam, Pondicherry, India, [3]Child Health Nursing, College of Nursing, P.I.M.S, Kanagachettikulam, Pondicherry, India, [4]Department of Emergency and Critical Care Medicine, Emergency Department, P.I.M.S, Kanagachettikulam, Pondicherry, India

Address for correspondence:
Mrs. Anandhi D. Amirtharaj, Department of Adult Health and Critical Care, College of Nursing, Sultan Qaboos University, Sultanate of Oman.
E-mail: anuamirtharaj@gmail.com

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Abstract:

BACKGROUND: Cardiovascular diseases (CVDs) are the leading cause of cardiac arrest (CA), which are presented as sudden cardiac arrest (SCA) and sudden cardiac death (SCD). To assess the impact of CPR duration on the functional outcome, level of independence, and survival among patients with in-hospital cardiac arrest (IHCA).

MATERIAL AND METHODS: This prospective longitudinal pilot study was conducted at a tertiary care hospital in South India. Data were collected using consecutive sampling techniques from nine patients with IHCA, and outcomes were measured using the cerebral performance category (CPC) and Katz level of independence (LOI) during the immediate post-CPR, 30th day, and 90th day. Based on the principles of pilot study design, descriptive statistics was used to analyze the results. Inferential statistics analysis was not applicable based on the sample size of the pilot study.

RESULTS: Nine patients were included in this pilot study. The mean and median age of the patients were 48.11 ± 8.66 (46, IQR, 32-67 years) and 77.8% were male patients. The primary medical diagnosis was cardiology and neurology conditions among 44.4% and 22.2% of patients. The mean and median CPR duration was 12.11 ± 4.59 minutes (IQR, 8-15.50) and 44.4% achieved a return of spontaneous circulation (ROSC) with a mean ROSC time of 5.56 ± 7.418. The mean CPC score in the immediate post-CPR period and 30th day was 4 ± 1.732 and 4.56 ± 1.33, with mortality of 66.7% and 33.3% survivors in the immediate post-CPR period. While the mean LOI score among the survivors during the immediate post-CPR and 30th day was zero and four. which highlights the complete dependency of patients during the immediate post-CPR with significant improvement by the 30th day and unchanged until the 90th day.

CONCLUSIONS: The overall mortality and survival were 88.8% and 11.1%, respectively, by the 90th day. The pilot study is feasible at the end of the study. However, due to the difficulty in obtaining CA, an additional tertiary hospital was included in the larger study.

Keywords:

Cardiac arrest, cardiopulmonary resuscitation, critical care outcomes, pilot study, return of spontaneous circulation

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Introduction

Cardiovascular Disease (CVD) emergencies are reported as sudden cardiac death (SCD) and sudden cardiac arrest (SCA), accounting for approximately 50% of all cardiovascular deaths in the general population. Most SCDs and SCAs are thought to be caused by arrhythmias with ventricular fibrillation in most cases, either with or without preceding ventricular tachycardia.[1,2] The available annual incidence of IHCA per 1000 hospital admissions in 2013 in the United Kingdom is 1.6-2.85,[3] 1.8 in Denmark and 5.1 in Japan, and with an overall survival rate of 25% in the United States, 18% in the United Kingdom, and 30% in Denmark and Sweden.[4] The World Health Federation, in a recent report on May 20, 2023, states that deaths from cardiovascular disease (CVD) have surged to 60% globally over the last 30 years.[5] Further adding to the burden of the disease, the World Health Organization, in their report on September 16, 2023, states that globally, around 17.9 million people die annually due to CVD's, cancers (9.3 million), respiratory diseases (4.1 million), and diabetes (1.5 million).[6] Management of cardiac arrest (CA) has to be quick and swift because a 100% mortality rate is definite if no resuscitation efforts have been made within the first 10 minutes.[7] Timely CPR improves survival by three to four times among 15–20% of all deaths.[8]

CVD is the most common cause of death (35.5%) in South Asia, as stated in a PURE sub-study conducted from 2003 to 2009 among India, Pakistan, and Bangladesh.[9] In India, CVD is the main significant cause of disability and the leading cause of fatality, accounting for 3.5 percent of all disabilities, as mentioned in the 2019 scoping review.[10] In the context of India, ambulance professionals are responsible for the transportation of just 10.54% of patients. Conversely, a significant proportion of patients, around 45.40%, are conveyed by their family members. Furthermore, police officers are involved in the transportation of 36.59% of patients, while onlookers contribute to the transportation of 7.47% of patients.[11] Research findings demonstrate the deficiencies within the prehospital healthcare system, namely in Denmark and Canada, where the rates of bystander CPR and automated external defibrillator (AED) utilization are reported to be 39.8% and 10.5% correspondingly.[12,13] Regrettably, there is a dearth of documented instances regarding the use of AEDs (AEDs) by individuals present at the scene in India.[14] Furthermore, the nation faces the absence of a consolidated emergency medical system.[15]

With the above data and statistics, it is observed that India does not have a unified Utstein style of formal CA registry and a centralized emergency medical system. The extensive search from evidence-based literature shows a higher incidence of CA with lower survival, discrepancy in termination of resuscitation (ToR), and lack of awareness regarding ToR guidelines in Southeast Asian countries. Hence, the main purpose of the pilot study is to assess if the duration of CPR has an effect on the functional outcome and level of independence (LOI) among cardiac arrest (CA) patients is to identify the effect of CPR duration on functional outcome of the patients measured with cerebral performance category tool (CPC) and level of independence (LOI) among CA patients.

A literature search identified several studies conducted globally to assess the CPR outcome of the patients. However, there is no similar research assessing the impact of CPR duration in prospective design, and no studies on LOI among cardiac arrests from South India. The prospective nature of the study assessing the above variable and assessment of LOI among the survivors is a unique perspective of this study. The main aim of the pilot study is to analyze the feasibility and precision of the study as an external pilot study independent of the full study to plan and amend modifications for the main study. The secondary aim of the study was to assess the functional outcome, LOI, and rate of survival at the end of 90 days of IHCA.

Materials and Methods

Study design and setting

This prospective longitudinal study is an external pilot study independent of the main study. This study was conducted among patients with in-hospital cardiac arrest (IHCA) from December 2021 to January 2022 at Pondicherry Institute of Medical Science, Pondicherry, which is a tertiary hospital with a 740-bed capacity that houses multispecialty departments. The outcome was measured immediately post-CPR on the 30th and 90th day.

Study participants and sampling

The study included the participants who developed CA while being admitted as In-hospital patients. During the pilot study, all adult patients above the age of 18 years who developed an IHCA were included. Patients who are COVID-positive or with cardiac implantable devices or with advance directives or "not for resuscitation" orders were excluded from the study. All consecutive (IHCA) in the emergency department, ICU, and ward were recruited based on the inclusion and exclusion criteria.

A consecutive sampling approach was used to identify IHCA patients. Activation of the code BLUE allowed the researcher to access patients with IHCA, as there was no specific time to determine the availability of the patient as this is a much marginalized and infrequent occurrence among the In-patients. Upon identification, the consent

for data collection and patient information sheet was collected from the significant others.

The pilot study used 10% of the main study's sample size. The sample size for the main study was calculated with the critical value at a 95% confidence interval, which is 1.96, with a 5% margin of error.

The principles of the CONSORT-EXTENSION reporting system were followed in the preparation of the manuscript.

Data collection tool and technique

Data were collected by observation and interview questionnaire technique. The questionnaire comprised three sections.

Section A included the sociodemographic and clinical variables.

Sociodemographic and clinical variables

Sociodemographic included the age, gender, region of origin, and marital status of the patients.

The clinical variables were structured based on the Utstein tool for reporting the IHCA. Clinical details specific to CA were incorporated. Initial and specific cardiac rhythm, time and location of CA, witness, time of initiation of the resuscitation, assistance in breathing, defibrillation, administration of lifesaving drugs, hemodynamic parameters, blood sugar, return of spontaneous circulation (ROSC), and total duration of the CPR was recorded in the checklist.

Section B included the outcome measures tool.

The outcomes measure section comprised of the two tools used for measuring the secondary outcome of the patients at three-time intervals, namely, immediate post-CPR, day 30, or at discharge, whichever was earlier and on day 90. The standardized tools used are the Glasgow Pittsburgh Cerebral Performance Scale (CPC) and Katz LOI.

The CPC tool is used to determine the favorable and unfavorable outcomes of the patients and has a reliability index of 0.71-0.78.[15] The CPC score ranges from 1 to 5, with patients categorized as having favorable outcomes with a CPC score of 1 or 2 while patients with CPC score of 3 and above were categorized as having unfavorable outcomes.[15-17]

The LOI comprising six items is used to assess the independence of patients in performing activities of daily living (ADL) with a Cronbach's α = 0.838 and test–retest reliability score of 0.999.[18] The LOI scores ranging from 0 to 6 were categorized as dependent, partially dependent, and independent for scores of 0-2, 3-5, and 6, respectively.[19,20]

The inter-rater reliability assessed was 0.85 based on the case scenario and two initial patients. Due to the small sample size, Cronbach's α reliability cannot be evaluated. However, Cronbach's α will be used to assess the reliability of the tools used for measuring the outcomes in the main study.

Nine patients, using the consecutive method of sampling, were recruited for this observational study. The sample size was calculated based on *a priori* Power Analysis with a type I error rate of 5% and 80% power due to infrequent cardiac arrests at the setting and the complexity of the situation due to COVID-19 at the time of the pilot study.

The STROBE guidelines in the selection of the patients are described in the flow chart in Figure 1.

Ethical consideration

The study proposal was presented to the hospital ethics committee, and ethical approval was obtained before data collection (IRB-PIMS/PhD (N)/20/14). The purpose of the study was explained, and consent was obtained from the next of kin in the family, who were mentioned as the significant others. None of the identifying information was collected from the significant others. The consenting individuals were given the freedom to withdraw their participation from the study at any point of time and were not forced to participate in the study. All the collected data were stored in a password-protected file. Only the investigators had access to the data.

Data analysis

Data were analyzed using Statistical Package for the Social Sciences (SPSS), version 23 203 (IBM Corp.,

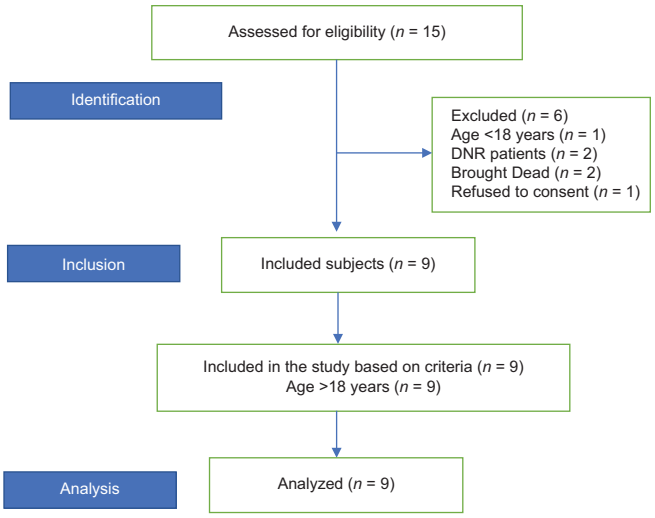

Figure 1: Flowchart of the patient selection process and outcome of interest

Armonk, New York, USA). Descriptive statistics, estimation, and confidence intervals were used as 95% based on the principles for pilot study analysis.[21] Based on the principles of the pilot study, testing of the hypothesis and inferential statistics were not applied.

The principles of the CONSORT-EXTENSION reporting system were followed in preparation of the manuscript.

Results

Nine patients were recruited in the study, seven of whom died in the immediate post-CPR time, and the remaining two patients were followed on the 30th day. On the 90th day, only one patient survived.

The demographic and clinical variables are presented in Table 1. The mean and median age of the participants was 48.11 ± 8.66 years and (46, IQR, 32,67 years), respectively. The minimum and the maximum age of the patients were 26 and 76 years, respectively. The majority of the patients were male (77.8%). The medical diagnosis on admission was primarily related to cardiac (44.4%) and Neuro (22.2%) conditions. 11.1% of patients reported no comorbid while 66.6% of admitted patients had one or two co-morbid conditions.

Clinical variables

Nine patients were recruited in the study of which eight (66.6%) of them presented with a history of minimum of one to two co-morbid diseases while three (22.2%) patients had three co-morbid diseases. It is significant to observe that four (44.4%) patients were admitted with an initial cardiac diagnosis, followed by two patients (22.2%) with neurology. This implies a strong relationship between co-morbid diseases and cardiovascular diseases.

All nine patients were admitted as in-hospital patients during the event of CA, which logically justifies the reason for 100% of witnessed CA, CPR being initiated within five minutes of collapse by health professionals. 66.7% of patients were admitted in ICUs, 22.2% in wards, and 11.1% of patients in emergency department during the event of CA. This signifies that the critical acuity of the patients admitted in the ICUs obviously increases the risk for the CA. The team leaders in seven (77.7%) events of CA were led by physicians or intensivists while two (22.2%) patients admitted in Emergency Medical Department (EMD) department were led by the nurses.

During the pilot study, it was observed that six (66.7%) of patients developed CA during the time period of 6 am to 6 pm while three (33.3%) patients developed CA after 6 pm.

The primary cause for CA was of cardiac origin, with all the patients having an initial non-shockable rhythm, specifically pulseless electrical activity (55.5%) and asystole (44.4%); hence, no patients were defibrillated during the resuscitation. All the patients admitted to ICUs were already receiving some form of assisted ventilation (66.7%), while the remaining 33.3% of patients were endotracheally intubated during the resuscitation. All Nine patients received Inj. Adrenaline during CPR, with 77.8% having received less than five ampoules. The mean and median blood sugar was 227.33 ± 151.761 and 162 (IQR, 95.5, 415.5), respectively.

The mean and median CPR duration was 12.11 ± 4.59 minutes (IQR, 8, 15.50), and 44.4% achieved ROSC with the mean ROSC time 5.56 ± 7.418 while the median and the IQR could not be determined to the limited sample size. The minimum and maximum CPR time was 6 and 20 minutes, respectively. The frequency distribution of the total duration of CPR is demonstrated in Figure 2.

Six (77.7%) patients could not be revived and were declared dead at the end of CPR. Of the three patients who survived, two patients died by day 30, and only one patient survived until day 90.

Outcome

a. Functional Outcome

The CPC score in the immediate post-CPR period showed a mean score of 4 ± 1.732 (IQR, 2.5-5) with mortality of 66.7% and 33.3% survivors. Of the survivors, 22.2% had a CPC score of 1 while 11.1% of patients were in a vegetative state. On follow-up on the 30th day, two patients died due to various complications. The one survivor had a CPC score of 2, which remained the same until the 90th day.

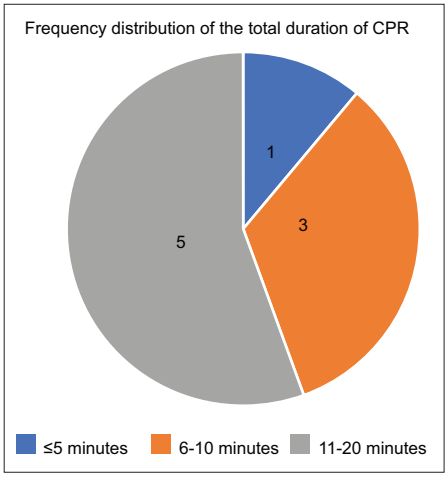

Figure 2: Frequency distribution of participants based on CPR duration among cardiac arrest patients

Table 2 represents the status of the patients in favorable and unfavorable states based on the CPC score.

The mean score of the functional outcome is mentioned in Table 3, which highlights a higher mean score toward unfavorable outcomes in all three observed periods. The IQR increased from three to five due to increasing mortality by the 30th and 90th day. The overall mortality rate was 88.8%, with 11.1% survivors by 90th day.

The high point of Table 4 is the increasingly unfavorable outcome of the patients with high mean score with increasing CPR duration. Table 4 displays a consistently increasing unfavorable outcome from the immediate post-CPR period until the 90th day due to increasing mortality.

b. Level of Independence

The LOI was assessed among the survivors. The number of survivors on the 30th day was three (22.2%), which further decreased to one (11.1%) patient by the 90th day. During the immediate post-CPR period, the three survivors were completely dependent, with a score of zero. The physical incapacitation is attributed to intubated status and sedation in the immediate post-CPR period. On reassessment, by the 30th day, there was just one survivor who improved to a partially independent state with LOI score of 5 and continued to remain in the same state until the 90th day. Since there were only three immediate post-CPR to and one survivor on the 90th day, it was not possible to compute meaningful mean and median score. With a large sample size, there is scope to acquire the mean and median score on the three observed dates.

The testing of hypothesis and inferential statistics are beyond the scope of the pilot study. However, provisional hypothesis testing with inferential statistics highlighted the significance of the below-given test. Pearson's correlation was significant for CPC score on the 30th and 90th day with P value of 0.021 ($P < 0.05$). At the same time, regression analysis identified ROSC time as a strong predictor of survival with the CPC score on the 90th day. The above highlights that there is a higher chance of identifying significant inferential statistics with higher samples.

While provisional inferential statistics could not be applied to the level of independence scores with three survivors; however, similar to CPC, there is scope to identify a significance with higher samples.

Table 1: Frequency and percentage distribution of demographic variables

Study variables	f	%
Gender		
Female	2	22.2
Male	7	77.8
Age		
18-30	2	22.2
31-40	2	22.2
41-50	2	22.2
51-60	1	11.1
61-70	0	0
>71 years	2	22.2
Marital status		
Single	2	22.2
Married	7	77.8
Separated		
Region		
Rural	2	22.2
Urban	7	77.8

Table 2: Favorable and unfavorable scores of functional outcomes among cardiac arrest patients

Sl no	Favorable		Unfavorable	
	f	%	f	%
Post-CPR	2	22.2	7	66.7
30th day	1	11.1	8	88.9
90th day	1	11.1	8	88.9

Table 3: Overall mean score of functional outcome among cardiac patients

Observation Period	Mean	Standard Deviation	IQR
Immediate post-CPR	4	1.732	3, 5
30th day	4.56	1.33	5, 5
90th day	4.56	1.33	5, 5

Discussion

The main purpose of the study was to assess the impact of CPR duration on the functional outcome, LOI, and survival among patients with IHCA. The study observed a mean age range of 48-56 years among the participants, which differs from the age range of 55-60 years commonly reported in worldwide and regional research.[22-24] This discrepancy can be attributed to the limited sample size utilized in the study. A study conducted by Atkins DL[25] (2019) reveals that around 30% of individuals below the age of 45 have been recorded to experience CA. The categorization of age underscores the heightened occurrence of CA as individuals grow older. This correlation has been substantiated by several study investigations, which consistently demonstrate that aging is associated with a greater susceptibility to non-communicable diseases, particularly those pertaining to the cardiovascular system, such as CA and sudden cardiac deaths.[26,27] Even when considering the limitations of a small sample size in this preliminary investigation, the significant prevalence of IHCA among males (77.8%) cannot be disregarded. This finding is consistent with previous research indicating that

Table 4: Comparison of mean score of functional outcome and CPR duration among patients with cardiac arrest

Duration of CPR	*n*	Mean Score in Immediate Post-CPR		Mean Score on 30th day		Mean Score on 90th day	
		Favorable	Unfavorable	Favorable	Unfavorable	Favorable	Unfavorable
≤5 mins	-	-	-	-	-	-	-
6-10 mins	4	1	5	1	5	1	5
11-20 mins	5	1	4.75	0	5	0	5
>20 mins	-	-	-	-	-	-	-

males are more susceptible to experiencing CA.[28-31] In a study focused on South Asian research pertaining to cardiovascular diseases (CVDs), it was shown that men exhibited a greater occurrence of CVD (6.42 vs. 3.91 per 1000 person-years) and a higher rate of death (10.66 vs. 6.85 per 1000 person-years) in comparison to females.[9] The aforementioned data highlight that, in relation to an unalterable element, individuals of the male gender have a higher susceptibility to experiencing CA.

SCA and SCD are significant contributors to overall mortality rates. It is important to note that all patients admitted to a hospital carry a potential risk of experiencing an IHCA.[22,28,29] While the American Heart Association has established strict standards for resuscitation, there is still a lack of recommendations pertaining to the ToR, specifically in cases of IHCA.[32,33] The bulk of studies undertaken in India regarding the duration of cardiopulmonary resuscitation (CPR) and its impact on functional outcomes have been retrospective in nature and have not adhered to the Utstein reporting standard.[34,35] The primary objective of this study is to evaluate the influence of cardiopulmonary resuscitation (CPR) duration on the functional outcome of patients experiencing IHCA.

Based on this study most of the participants had minimum of one to two comorbid diseases, and less than 50% of the patients presented with an initial cardiac diagnosis, which is supported to the findings in the Global Burden Disease Report, which states that high systolic blood pressure accounted for 10.8 million (95% CI: 9.15-12.1 million) cardiovascular deaths and 11.3 million (95% CI: 9.59-12.7 million) deaths overall in 2021.[36] The report also highlighted an interesting fact that dietary risks accounted for 6.58 million (95% CI: 2.27-9.52 million) cardiovascular deaths and 8 million (95% CI: 3.03-11.8 million) deaths overall in 2021.[36] The 77.8% of participants of the study belong to an urban community, and a study performed by Armstrong AdC *et al*.[26] identifies that lifestyle and environmental changes from urbanization are core reasons for the increased risk of CVD. Based on the Utstein registry for IHCA template, the clinical variables in this study highlight that the majority of the patients admitted to intensive care units developed IHCA, and this is supported by the research DANARREST in Denmark, which reports 0.06% IHCA while a study in Japan reports 5.1 CAs per 1000 from 2011 to 2017 that confirms the high risk of cardiac events among the IHCA.[37] Similarly, research performed in Denmark on IHCA vs OHCA illustrates a 3:1 ratio in incidence and favorable outcomes among the IHCA.[27] In a study performed in Taiwan highlighted increased mortality among IHCA patients in general wards due to high disproportionate nurse-patient ratio, which causes an overload of patient assignments.[38] Increased mortality was observed among the 66.6% of patients who developed cardiac arrest during 6:00-18:00 hours while, in contradiction, a study conducted by Wang, MT *et al*.[38] highlights higher survival rates among events of IHCA during the day. The findings of this study can be deferred owing to the small sample size in this pilot study. All nine patients who developed an IHCA had an initiation of CPR from collapse within 5 minutes by health care professionals, and this is justifiable considering the units of admission such as ICU and EMD which has uninterrupted monitoring by physicians, staff nurses, and 1:1 staff-patient ratio.

The initial cardiac rhythm in this study among all nine patients was non-shockable rhythm, specifically pulseless electrical activity, which is supported by several research studies that identified non-shockable rhythm-pulseless electrical activity or asystole.[37,39-41] Similarly, a systematic review reports a non-shockable rhythm among 69.83% and a shockable rhythm among 21.75%,[42] while in contrast favorable outcomes are reported among patients with a shockable rhythm.[37,38] No patients were defibrillated due to the initial non-shockable rhythm. In contrast, all nine patients received the lifesaving drug Inj. Adrenaline during the resuscitation of which 77.8% of patients received less than five ampules, and this remains controversial to the beneficial effects in sustained ROSC with the utility of epinephrine, while there is consensus that shorter interval of defibrillation from collapse increases the chances of survival among IHCA with shockable rhythm.[43] The mean CPR duration is 12.11 ± 4.59 and the median CPR duration is 12 minutes, IQR 8, 15.5 minutes. This is corroborated by several research studies that demonstrated a median CPR duration of 17-25 minutes with decreasing survival rates directly proportional to increasing duration of CPR.[27,44-47] Of the nine patients, five (55.6%) were resuscitated for more than ten minutes. At the end of CPR, the mortality rate was 66.7%, with a survival of 33.3%, and this is supported by a systematic review that reports

in-hospital mortality at 51% with a decreasing trend with the induction of ECMO as a novel and crucial part of the resuscitation strategy.[48] The ROSC was achieved among 33.3% with a mean ROSC time of 5.56 ± 7.418 while other studies reported 61-70% achieving ROSC,[41] while; in contrast, only 13.2% achieved ROSC during the COVID-19 infection.[41]

The rate of ROSC and 30-day survival was 33.3%, while a Swedish study reported 63% and 30%, respectively,[49] and a Demark study reports 49% Vs 27% of ROSC 24% and 17%[27] survival at 30 days among IHCA and OHCA. The reassessment was performed among the survivors on the 30th day, which was 11.1% until the 90th day. The CPC with good cerebral outcome among the survivors in the immediate post-CPR period was 22.2%, and 11.1% of survivors were in a vegetative state. The cumulative mortality on the 30th day was 88.8%, with one survivor in moderate cerebral disability. This is supported by a Denmark study, which shows a 30-day and 1-year survival among IHCA to be 48% and 37% and OHCA 51% and 44%.[27] While a European research study reported an increased survival rate of 47% among the IHCA over the last decade, with a 1.2-fold times improvement among male and younger patients.[50] The Resuscitation Predictor Tool developed by Cooper *et al*. predicts a 3.8% chance of survival to 24 hours among patients older than 70 years with a primary cardiac cause of arrest with an initial non-shockable rhythm.[33] Similarly, a systematic review performed among 92 IHCA studies found very low certainty evidence supporting the UN10 rule of unwitnessed arrest, no ROSC within 10 minutes of resuscitation for an initial non-shockable rhythm, and no conclusions on recommendations of termination of CPR among IHCA. Similarly, tools like the Good Outcome Following Attempted Resuscitation (GO-FAR) score and clinical frailty scale can steer clinicians on DNR decision-making and do not recommend ToR.[33] The overall survival in this study is very similar to most studies, concluding that a rapid decrease in favorable outcomes is directly correlated to a few minutes of CPR and that the clinical features of the patients influence the impact of CPR.

The LOI assessed among the survivors demonstrated a decreasing quality of life in post-CPR, 30th and 90th day, and this is supported by a study conducted by Song IA., which highlights decreasing quality of life among the survivors with high mortality by the 90th day.[51] Only one study by Pound *et al*.[24] measured the outcome using the Katz LOI study, reporting that 63.3% of patients were independent at the time of discharge. Hence, a conclusive validation cannot be based on a single study, and a more large-scale study must be duplicated to identify the correlation of LOI among CA patients. The mean and median blood sugar were 227.33 ± 151.761, 162, (IQR, 95, 415), respectively, while a retrospective reported the intra-arrest blood sugar to be 191.5 mg/dl and with 9.8% of patients in hypoglycemia significant with worse neurological recovery.[52] While a retrospective study conducted in Thailand identified hypoglycemic patients during intra-arrest and received dextrose administration during CPR showed no significance or association to ROSC, survival at the end of CPR concluded that dextrose administration did not lead to better or worse resuscitation outcomes.[53]

Regrettably, as a consequence of the COVID-19 pandemic, the admission rates for critically sick patients have experienced a significant decrease as a result of the redirection of admissions to regional government hospitals. This might be attributed to the anticipated financial burden associated with in-hospital costs at private healthcare facilities. The aforementioned circumstance had a significant impact on the accessibility of the participants during the implementation of the pilot project. Therefore, it was determined at the conclusion of the pilot project to incorporate an additional tertiary care hospital. The applicability of the evaluation on day 30 may be limited among all survivors due to the fact that a significant number of them were discharged from the hospital before reaching day 30. Therefore, the result on the 30th day was redefined as either the 30th day or the day of discharge.

Nursing practice must be based on principles of evidence-based practice to achieve high-quality, comprehensive care. Hence, it is important that the findings of the nursing research are implemented in practice to maintain standards of practice. Based on the findings of the pilot study, a mean time CPR of 20 minutes is acceptable, and prolonging the duration of CPR in the absence of ROSC must be avoided. ToR guidelines with specific criteria for termination must be instituted to guide the health care professionals. The type of rhythms during CA must observed for better management. Adult Early Warning Signs must be implemented in High Dependency Units and step-down units for early identification of deterioration and proactively preventing CA. Nurses must be diligent and be updated with American Heart Association protocols and guidelines with the renewal of the Basic Life Support (BLS) and Advanced Cardiac Life Support (ACLS) certification for accuracy in implementing the CPR techniques for high efficacy outcomes.[54]

The findings of the nursing research must be implemented as policies and guidelines for achieving and maintaining the highest standards of care. The findings of this study urge the need to introduce the Utstein template for accurate documentation for in-hospital and out-of-hospital cardiac arrest patients. More prospective studies related to CPR duration and its outcome must be studied. New guidelines and protocols must be

instituted for early identification of critically ill patients and to anticipate CPR. Nurses in clinical units must have scheduled Continued Nursing Education programs to be trained hands-on with CPR techniques.

Nursing curriculum forms the foundation for a revolution in practice. Hence, no changes can be implemented or generated if nursing curriculum is not periodically revised and updated, and novel ideas are incorporated into the course content. The findings of this study advocate the need to introduce the concept of in-hospital and out-of-hospital cardiac arrest patients and their management.[55] SCA and SCD are new variations in CA, and the definition and management must be part of emergency nursing. The students should be introduced to the concept of CA and its management through simulation and provided with hands-on learning with the techniques and dexterity in performing CPR. The curriculum must focus on Evidence Based Practice (EBP) and incorporate updated changes in practice.

Limitations and recommendation

The study limitations were that no participants of the pilot study had an initial shockable rhythm, and no defibrillation was administered during intra-cardiac arrest. While this is significant information based on similar research and relevant to the outcome of the study, it was decided to retain the above information in data collection with the expectation that participants with shockable rhythms would be available during the main study.

Conclusion

The pilot study findings accomplished the aim and objectives of the study. Hence, the findings of the pilot study conclude the project is feasible and appropriate to be conducted as a large-scale main study. There are no modifications in the data collection methods or tools. The sporadic availability of CA patients compels the researcher to have an alternative setting for data collection. The study findings also recommend the use of an infrared pupilometer, cardiac standstill, no ROSC and $ETCO_2$ of lesser than 10 mmHg after 20 minutes of CPR to be considered as criteria for termination and should be introduced as policy and guideline to direct the team leaders in ToR decision-making.

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Authorship statement

The author is Ph.D. scholar at Pondicherry Institute of Medical Sciences, Pondicherry, affiliated to Pondicherry University.

All authors have made substantial contributions to all of the following: (1) the conception and design of the study, or acquisition of data, or analysis and interpretation of data, (2) drafting the article or revising it critically for important intellectual content, and (3) final approval of the version to be submitted. Statement of authorship: All authors take responsibility for all aspects of the reliability and freedom from bias of the data presented and their discussed interpretation.

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Conflicts of interest

There are no conflicts of interest.

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