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Original Article

Advanced Cardiac Life Support Compliance and Outcomes in In-Hospital Cardiac Arrests: A Prospective Observational Study

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ABSTRACT

Background: Advanced Cardiac Life Support (ACLS) guidelines are designed to improve outcomes following cardiac arrest. However, real-world compliance varies, potentially affecting survival rates. **Materials and Methods:** This prospective cross-sectional study analyzed 85 In-Hospital Cardiac Arrest (IHCA) cases over six months at the Department of Emergency Medicine, SVIMS, Tirupati. ACLS protocol adherence was assessed using a standardized checklist covering airway management, ventilation, CPR quality, defibrillation, medication administration, and documentation. The primary outcome was Return of Spontaneous Circulation (ROSC); secondary outcomes included survival to admission/discharge and neurological status (Cerebral Performance Category, CPC). Data were analysed using chi-square tests and descriptive statistics (SPSS v27). **Results:** ROSC was achieved in 57 of 85 cases (67.1%). Early CPR initiation and ROSC within 10 min were significantly associated with better outcomes ($p<0.001$). High-quality chest compression rates (100-120/min) were maintained in 32.9% (28/85), and adequate depth (5-6 cm) in 64.7% (55/85). Among patients with shockable rhythms (58/85), only 4 (6.9%) received defibrillation within the recommended 2-min window. Epinephrine was administered appropriately in all cases. Documentation quality was high, with 90.6% (77/85) of events fully recorded. **Conclusion:** Improved compliance with ACLS protocols-especially timely CPR, early defibrillation for shockable rhythms, and proper medication timing-is strongly associated with higher ROSC rates in in-hospital cardiac arrest. Identified gaps, particularly in defibrillation timing and CPR quality, highlight the need for targeted training, regular audits, and strict protocol adherence.

Keywords: ACLS, In-Hospital Cardiac Arrest, ROSC, CPR Quality, Defibrillation, Protocol Compliance.

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INTRODUCTION

Cardiac arrest is defined as the sudden and complete cessation of effective cardiac mechanical activity, resulting in the absence of a detectable pulse and perfusion. It is a time-sensitive medical emergency that demands immediate recognition and prompt initiation of resuscitative measures to prevent irreversible organ damage and death. Management of cardiac arrest has been standardized through the Advanced Cardiac Life Support (ACLS) guidelines, formulated and regularly updated by the American Heart Association (AHA). These guidelines recommend a sequence of evidence-based interventions, including high-quality Cardiopulmonary Resuscitation (CPR), early defibrillation in shockable rhythms, effective airway management, timely administration of vasopressors and antiarrhythmic drugs, and structured post-resuscitation care aimed at optimizing neurological and hemodynamic recovery (Patel and Hipskind, 2023).

In-hospital cardiac arrest remains a significant clinical challenge, with survival rates varying widely across institutions. The American Heart Association's Advanced Cardiac Life Support (ACLS) guidelines serve as the standard for managing such emergencies, emphasizing early defibrillation, high-quality chest compressions, and timely administration of medications (McEvoy *et al.*, 2014; Honarmand *et al.*, 2018; Crowley *et al.*, 2020).

Despite these established protocols, adherence to ACLS guidelines often falls short, potentially impacting patient outcomes. Studies have demonstrated that deviations from ACLS protocols, including errors of omission and commission, are associated with reduced rates of Return of Spontaneous Circulation (ROSC) and lower survival to discharge rates. Furthermore, the timing of interventions, such as the prompt administration of epinephrine

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and defibrillation, plays a critical role in patient survival (McEvoy *et al.*, 2014). Identifying barriers to ACLS compliance-such as inadequate training, resource limitations, and workflow inefficiencies-is essential for improving resuscitation outcomes. This study aims to evaluate the impact of ACLS protocol adherence on ROSC rates, assess its effect on survival to discharge and post-discharge outcomes, analyze the association between the timing of interventions and patient survival, and identify clinical barriers to guideline compliance.

Despite the availability of such detailed protocols, real-world adherence to ACLS recommendations often varies due to multiple factors, including human error, team coordination issues, resource limitations, and situational complexity during cardiac arrest scenarios (Honarmand *et al.*, 2018). Studies have shown that noncompliance-whether by omission (failure to perform a necessary step) or commission (performing an action incorrectly or at the wrong time)-can significantly reduce the likelihood of achieving Return of Spontaneous Circulation (ROSC) and may adversely impact both short- and long-term survival (Honarmand *et al.*, 2018).

Previous research has indicated that implementation of regular training programs, mock drills, and compliance audits can improve performance and outcomes. However, gaps still exist in consistently translating guidelines into bedside practice across different hospital settings (Lockey *et al.*, 2018). Given this context, evaluating actual compliance with ACLS protocols during in-hospital cardiac arrests is essential to identify specific areas of deficiency and to guide targeted quality improvement efforts.

This study was undertaken to assess the level of adherence to ACLS protocols during in-hospital cardiac arrest events at a tertiary care hospital and to examine how protocol compliance influences clinical outcomes, particularly ROSC, early survival, and neurological status (Honarmand *et al.*, 2018).

Aim

To assess the level of compliance with Advanced Cardiac Life Support (ACLS) protocols during in-hospital cardiac arrest resuscitation and to examine its impact on ROSC and early survival outcomes.

Objectives

- To evaluate the impact of ACLS protocol compliance on ROSC rate.
- To determine the effect of compliance on survival rates to hospital discharge and post-discharge outcomes.
- To determine the association between the timing of ACLS interventions and patient survival rates.
- To identify barriers to ACLS protocol adherence in the clinical setting.

MATERIALS AND METHODS

Study Design

This research was conducted as a prospective, cross-sectional, observational study in the Department of Emergency Medicine at Sri Venkateswara Institute of Medical Sciences (SVIMS), Tirupati, over a six-month period. The study aimed to evaluate 85 in-hospital cardiac arrest cases where the resuscitation team implemented ACLS protocols.

Study Criteria

Inclusion Criteria

- Adult patients (aged ≥18 years) who experience in hospital cardiac arrest.
- Patients who experienced a cardiac arrest within the hospital during the study period.
- Resuscitate efforts carried out in accordance with ACLS protocols.

Exclusion Criteria

- Cardiac arrests occurring outside hospital settings.
- Patients with existing Do Not Resuscitate (DNR) orders.
- Terminally ill patients with a prognosis unlikely to improve regardless of resuscitation efforts.
- Events lacking sufficient documentation to allow assessment of ACLS protocol adherence.

Ethical Considerations

Approval for the study was obtained from the Institutional Ethics Committee of SVIMS (Approval No: AS/11/IEC/SVIMS/2017-1787). Where applicable, informed consent for data collection was obtained from the patient's legally authorized representatives. For retrospective data or institutional code blue documentation, review was conducted in accordance with hospital policy on quality improvement and clinical event audit.

Study Procedure

Patients will be selected for the study based on specific inclusion and exclusion criteria. Prior to enrollment, informed consent will be obtained from the patient's caretaker. Data collection will be carried out using a structured form designed to capture relevant information, including patient demographics, medical history, details surrounding the cardiac arrest event, and the Advanced Cardiac Life Support (ACLS) measures provided. This includes documentation of defibrillation, airway management, medication administration, and the timing of each intervention

(McEvoy *et al.*, 2014). To assess adherence to ACLS protocols, a standardised compliance checklist will be used, and each case will be categorized as either compliant or non-compliant based on this assessment. Key patient outcomes such as Return of Spontaneous Circulation (ROSC), survival to hospital discharge, neurological status at discharge, and post-discharge follow-up will also be documented as part of the study.

ACLS Compliance Assessment

To assess adherence to ACLS protocols, a standardised checklist will be utilised as a structured tool for systematically evaluating compliance during resuscitation efforts. This checklist will cover all essential components of the ACLS guidelines, including airway management, defibrillation, administration of medications, Cardiopulmonary Resuscitation (CPR), and the timing of each intervention. Its use will ensure that each aspect of the protocol is thoroughly reviewed. Any deviation from the checklist criteria will be considered a breach of protocol and noted accordingly.

RESULTS

For statistical analysis, appropriate tests will be applied to evaluate the collected data using SPSS software, version 27. A *p*-value of less than 0.05 will be considered statistically significant.

Frequency distribution of gender

Among 85 subjects enrolled in the study, 58(69%) patients were males and 26(31%) patients were females. Frequency of gender distribution is shown in Figure 1.

Freguency of Age Distribution

A total of 85 subjects were enrolled in the study. Among them, 26(30.6%) are between the age of 61-70 years, 23(27.1%) are between the age of 51-60 years, 21(24.7%) are between the age of 71-80 years, 5(5.9%) are between the age of 41-50 years, 4(4.7%) are between the age of 20-40 years and 2(2.4%) are between the age of 81-90 years. Frequency of age distribution is shown in Figure 2.

Overall compliance for each ACLS domain

In this study involving 85 participants, adherence to ACLS protocols differed across various components of resuscitation. Airway management was partially effective, with bag-mask ventilation and advanced airway techniques frequently applied, although recommended ventilation rates were not consistently followed. Oxygen delivery was adjusted appropriately in most cases, showing strong compliance in this area. While adequate chest compression depth was achieved in the majority, optimal compression rate and full chest recoil were less commonly observed. Defibrillation typically used correct energy settings, but timely application for shockable rhythms and immediate CPR afterwards were limited. Monitoring of cardiac rhythm was promptly initiated with the use of a monitor or defibrillator, yet rhythm checks at 2-min intervals during CPR were rare. Medication protocols were followed well for epinephrine and timely administration, whereas adherence to amiodarone or lidocaine use was moderate. Overall, the findings indicate high compliance in critical interventions like oxygen delivery and epinephrine use, with room for improvement in chest recoil, rhythm monitoring, and timely defibrillation (Table 1).

In this study of 85 in-hospital cardiac arrest cases, the majority of events (72.9%) were witnessed, and ventricular fibrillation was the most common initial rhythm (40%), followed by pulseless electrical activity (35.3%), asystole (23.5%), and pulseless ventricular tachycardia (1.2%). Arrest recognition was rapid, with 69.4% identified within the first minute, and CPR was initiated promptly, with 47.1% receiving it within 1 min and an additional 34.1% within 2 min. First defibrillation occurred within 2-3 min in 43.5% of cases, though 12.9% experienced delays beyond 6 min. Assessment of ACLS protocol adherence revealed generally good compliance with airway management,

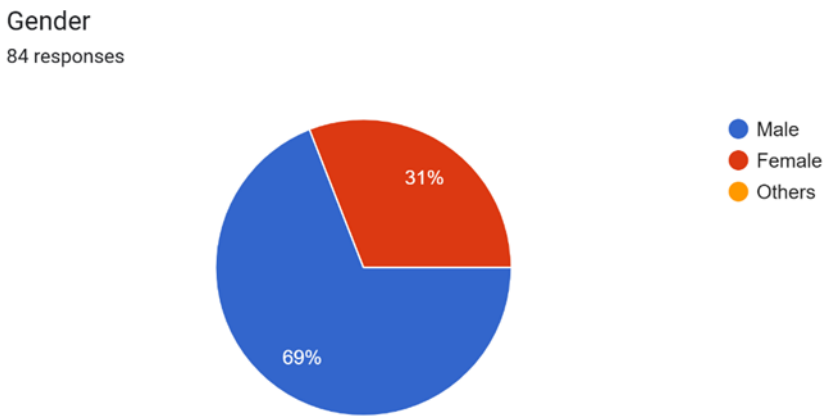

Figure 1: Frequency distribution of gender.

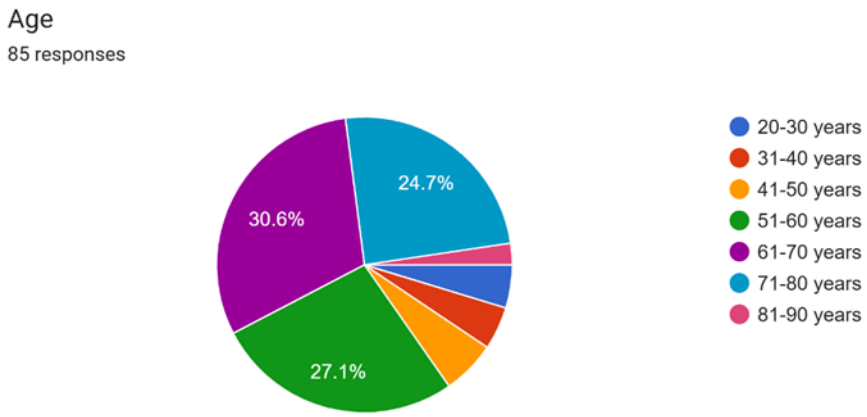

Figure 2: Frequency of age distribution.

Table 1: Overall compliance for each ACLS domain.

Domain	Summary of Compliance	Overall Compliance (%)
Airway Management	Bag-mask ventilation, endotracheal intubation, or airway maintained appropriately.	42-49% (most received bag-mask or advanced airway)
Breathing & Oxygenation	Oxygen delivery adjusted according to patient condition; a few received initial 100% oxygen.	97.6
Circulation & Chest Compressions	Adequate compression depth was achieved in most; a high-quality rate was maintained in ~1/3; chest recoil was rarely ensured.	32.9-64.7
Defibrillation	Appropriate energy is used in the majority; prompt defibrillation for shockable rhythms and immediate CPR are less common.	6.9-69
Rhythm Analysis & Monitoring	Monitor attached promptly in most cases; rhythm assessed every 2 min during CPR infrequently.	7.1-94.1
Medication	Epinephrine administered per protocol; medications given promptly; amiodarone/lidocaine compliance moderate.	42.4-100

ventilation, and high-quality CPR, while timely defibrillation showed room for improvement. Overall, the findings indicate efficient recognition and initiation of resuscitation in most cases, highlighting strengths in CPR delivery while emphasizing the need for optimized defibrillation timing to improve patient outcomes (Table 2).

Resuscitation Team Performance and ACLS Interventions

In this study of 85 in-hospital cardiac arrest cases, immediate CPR was administered in 75.3% of patients, while 32.9% received high-quality chest compressions at the recommended rate of 100-120/min. Adequate compression depth (5-6 cm) was achieved in 64.7% of cases, and all patients received CPR with an appropriate compression-to-ventilation ratio. Frequent rescuer switches (<2 min) occurred in 98.8% of cases, and continuous capnography monitoring was implemented for all patients (Andersen *et al.*, 2019).

Regarding ACLS interventions, 67.9% of patients received defibrillation, and 100% received high-quality chest compressions, epinephrine (1 mg every 3-5 min), and advanced airway placement. Amiodarone or lidocaine was administered in 42.9% of cases. Reversible causes were considered in 76.5% of patients.

Communication and Team Dynamics were excellent: all cases had clear communication, effective leadership with role allocation, closed-loop communication, and team debriefing post-event in 83 of 85 cases.

Outcomes of Resuscitation showed that Return of Spontaneous Circulation (ROSC) was achieved in 67.1% of patients, with 45.9% achieving ROSC within 1-10 min. Survival to hospital admission occurred in 64.7%, but none survived to hospital discharge. Only 1 patient (1.2%) survived at 30 days. Neurological assessment using the Cerebral Performance Category (CPC) score revealed

good Cerebral Performance (CPC 1) in 65.9% of patients, severe disability (CPC 3) in 18.8%, and brain death (CPC 5) in 15.3%.

Documentation Quality was high, with 90.6% of events fully documented in medical records. All interventions were clearly timed and recorded in 92.9% of cases, and medications and doses were accurately documented in 84.7% of cases (Table 3).

Statistical Analysis

Data were entered and analysed using SPSS Version 27. Descriptive statistics (mean, standard deviation, frequency, and percentage) were used to summarize patient characteristics and compliance data. Chi-square tests were applied to evaluate the association between protocol compliance and outcomes such as ROSC and survival to hospital admission. A *p*-value less than 0.05 was considered statistically significant. Confidence intervals (95%) were calculated for key outcome proportions to enhance result interpretation

Table 4 summarizes the association between Return of Spontaneous Circulation (ROSC) and various clinical and demographic variables in patients with cardiac arrest (n=85). For each comparison, the frequencies of patients who achieved ROSC (Yes) and those who did not (No) are presented, along with the total number of cases in each category. Chi-square (χ^2) tests were conducted to determine whether there were statistically significant associations between the variables and ROSC. A p-value < 0.05 was considered statistically significant (Elmer *et al.*, 2016).

Association between Gender and ROSC

- Among 85 patients, 82% of males achieved ROSC compared to 34% of females.
- The chi-square test (χ^2=14.9, p=0.0001) confirmed this difference was statistically significant.
- This suggests that gender is significantly associated with ROSC, although clinical confounders may exist.

Table 2: Cardiac Arrest Event Summary.

Event	Observation/Time	Frequency (n=85)	Percentage (%)
Type of Cardiac Arrest	In-hospital cardiac arrest	85	100
	Out-of-Hospital (OHCA)	0	0
Witnessed Arrest	Yes	62	72.9
	No	23	27.1
Initial Rhythm	Ventricular Fibrillation (VF)	34	40
	Pulseless Ventricular Tachycardia (pVT)	1	1.2
	Asystole	20	23.5
	Pulseless Electrical Activity (PEA)	30	35.3
Time of Arrest Recognition	Within 1 min	59	69.4
	Within 2 min	16	18.8
	Within 3 min	5	5.8
	Within 4 min	4	4.7
	Within 5 min	1	1.1
Time CPR Started	Within 1 min	40	47.1
	Within 2 min	29	34.1
	Within 3 min	9	10.5
	Within 4 min	1	1.1
	Within 5 min	6	7.1
Time of First Defibrillation	Within 2-3 min	37	43.5
	Within 3-4 min	4	4.7
	Within 4-5 min	6	7.1
	Within 5-6 min	1	1.1
	Within 6-7 min	11	12.9

Table 3: Combining cardiac arrest event details and resuscitation/ACLS performance, outcomes, and documentation.

Domain	Parameter	Frequency (*n*=85)	Percentage (%)
Resuscitation Team Performance	CPR started immediately	64	75.3
	High-quality chest compressions (rate 100-120/min).	28	32.9
	Adequate compression depth (5-6 cm)	55	64.7
	Appropriate compression-to-ventilation ratio.	85	100
	Frequent switch of rescuers (<2 min)	84	98.8
	Continuous capnography monitoring	85	100
ACLS Interventions	Defibrillation	58	67.9
	High-quality chest compressions	85	100
	Epinephrine (1 mg every 3-5 min)	85	100
	Amiodarone (300/150 mg) or Lidocaine.	36	42.9
	Advanced airway placement	85	100
	Reversible causes considered	65	76.5
Team Communication & Dynamics	Clear communication among team members.	85	100
	Effective leadership & role allocation	85	100
	Closed-loop communication practiced	85	100
	Team debriefing post-event	83	100
Resuscitation Outcomes	ROSC achieved	57	67.1
	Time to ROSC 1-10 min	39	45.9
	Time to ROSC 11-20 min	18	21.2
	Time to ROSC not achieved	28	32.9
	Survival to hospital admission	55	64.7
	Survival to hospital discharge	0	0
	30-day survival	1	1.2
	CPC 1 (good cerebral performance)	56	65.9
	CPC 2 (moderate disability)	0	0
	CPC 3 (severe disability)	16	18.8
	CPC 4 (coma/vegetative state)	0	0
	CPC 5 (brain death)	13	15.3
Documentation Quality	Event fully documented in medical record	77	90.6
	All interventions clearly timed & recorded	79	92.9
	Medications & doses accurately documented	72	84.7

Association between Age Group and ROSC

• Younger patients had consistently higher ROSC rates, especially those under 60 years.

• ROSC declined sharply in older patients: only 28% in 71-80 years, and none above 80 years.

• Chi-square test (χ^2=27.6, p<0.001) showed a strong significance.

• Advancing age is strongly associated with poorer outcomes.

Association between Initial Rhythm and ROSC

• Shockable rhythms (VF/pVT) showed better outcomes: 88% ROSC in VF and 100% in pVT, versus 30% in asystole and 67% in PEA.

• Chi-square test (χ^2=18.8, p<0.001) confirmed statistical significance.

• Initial rhythm is one of the strongest predictors of ROSC.

Association between Witnessed Arrest and ROSC

• ROSC was achieved in 80% of witnessed arrests vs 36% of unwitnessed arrests.

• Chi-square test (χ^2=11.7, p=0.0006).

• Witnessed arrest is strongly associated with improved ROSC outcomes.

Association between Immediate CPR and ROSC

• Immediate CPR led to 78% ROSC, compared with 33% when delayed.

• Chi-square test (χ^2=10.8, p=0.0010).

• Immediate CPR is strongly linked to ROSC success.

Association between Defibrillation and ROSC

• Patients receiving defibrillation: 83% ROSC, compared with 33% without.

• Chi-square test (χ^2=14.1, p=0.0002).

• Defibrillation is significantly associated with higher ROSC rates.

Association between Amiodarone Use and ROSC

• Patients given amiodaro.ne (refractory VF/pVT) had 86% ROSC, vs 53% without.

• Chi-square test (χ^2=7.7, p=0.0055).

• Amiodarone significantly improves ROSC in shockable rhythms (Fugate and Rabinstein, 2014) (Table 3).

DISCUSSION

The study revealed that 43.5% of patients received the first defibrillation within 2-3 min, while 12.9% experienced delays beyond 6 min. Delayed defibrillation is a well-established determinant of survival in hospital cardiac arrest (Chan *et al.*, 2008). Research indicates that each minute of delay in defibrillation is associated with a significant decrease in survival rates. Specifically, every minute of delay to the first shock was linked to a lower proportion of ventricular fibrillation termination and return of organised rhythm. Additionally, a study found that delayed defibrillation was associated with a significantly reduced probability of survival to hospital discharge (Chan *et al.*, 2008).

The study demonstrated high compliance with ACLS protocols, including immediate CPR initiation (75.3%), appropriate

Table 4: The association between Return of Spontaneous Circulation (ROSC) and various clinical and demographic variables in patients with cardiac arrest (*n*=85).

Comparison Category	Subcategory	ROSC Yes (n)	ROSC No (n)	Chi²	d_f	*p*-value	Significance
Gender vs ROSC	Male	48	10	14.9	1	0.0001	Significant
	Female	9	18				
	Total	57	28				
Initial Rhythm vs ROSC	VF	30	4	18.8	3	<0.001	Significant
	pVT	1	0				
	Asystole	6	14				
	PEA	20	10				
	Total	57	28				
Witnessed Arrest vs ROSC	Witnessed	48	12	11.7	1	0.0006	Significant
	Unwitnessed	9	16				
	Total	57	28				
CPR Immediate vs ROSC	Immediate	50	14	10.8	1	0.0010	Significant
	Not Immediate	7	14				
	Total	57	28				
Defibrillation vs ROSC	Yes	48	10	14.1	1	0.0002	Significant
	No	9	18				
	Total	57	28				
Amiodarone vs ROSC	Yes	31	5	7.7	1	0.0055	Significant
	No	26	23				
	Total	57	28				

compression-ventilation ratios (100%), and continuous capnography monitoring (100%). Adherence to ACLS guidelines has been consistently associated with improved outcomes in hospital cardiac arrest (Sandroni *et al.*, 2007). A study by McEvoy *et al.* found that adherence to ACLS protocols throughout an event is correlated with increased Return of Spontaneous Circulation (ROSC) in the setting of cardiac arrest. Furthermore, a study by Hessulf *et al.* reported that adherence to ACLS guidelines during in-hospital cardiac arrest is associated with improved outcomes.

Effective team dynamics are pivotal in resuscitation efforts. The study highlighted that all cases involved clear communication among team members (100%), effective leadership and role allocation (100%), and closed-loop communication (100%). These practices are essential for coordinated and efficient patient care (Nallamothu *et al.*, 2023). A study by Malik *et al.* found that hospital debriefing frequency was associated with better adherence to the timely delivery of epinephrine or defibrillation and higher rates of in-hospital cardiac arrest survival (Sandroni *et al.*, 2007).

The findings emphasise the necessity for hospitals to implement and maintain rigorous training programs to ensure rapid defibrillation and strict adherence to ACLS protocols (Stieglis *et al.*, 2025; Merck Manual Consumer Version, 2023). Regular simulation-based training can enhance team preparedness and response times. Additionally, hospitals should invest in continuous quality improvement initiatives to monitor and improve resuscitation practices. Implementing real-time feedback mechanisms during resuscitation events can further optimise outcomes (Girotra *et al.*, 2012; Kantamineni *et al.*, 2014).

CONCLUSION

The implementation of Advanced Cardiovascular Life Support (ACLS) guidelines plays a crucial role in improving survival outcomes in cardiac arrest patients, particularly within emergency care settings. This study has demonstrated a statistically significant association between adherence to ACLS protocols and the achievement of Return of Spontaneous Circulation (ROSC).

Patients who received timely and structured resuscitation as per ACLS standards-including immediate recognition of cardiac arrest, initiation of high-quality Cardiopulmonary Resuscitation (CPR), rapid defibrillation when indicated, and systematic post-resuscitation care-showed a markedly higher rate of ROSC. Specifically, the ROSC rate among patients treated with full ACLS compliance significantly exceeded the rate expected by chance alone, as evidenced by chi-square testing ($p<0.05$).

These findings highlight the importance of continuous training and skill reinforcement for emergency personnel in ACLS protocols. Furthermore, institutional emphasis on protocol adherence, availability of necessary equipment, and real-time team coordination are integral to improving cardiac arrest outcomes.

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ABBREVIATIONS

ACLS: Advanced Cardiac Life Support; **ROSC:** Return of Spontaneous Circulation; **IHCA:** In-Hospital Cardiac Arrest; **CPR:** Cardio-Pulmonary Resuscitation; **VF:** Ventricular Fibrillation.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

SUMMARY

This prospective observational study evaluated 85 cases of In-Hospital Cardiac Arrest (IHCA) to assess compliance with Advanced Cardiac Life Support (ACLS) protocols and related outcomes. The majority of arrests were witnessed, and ventricular fibrillation was the most common presenting rhythm. While CPR was initiated promptly in most cases, only one-third received compressions at the recommended rate, and adequate compression depth was achieved in about two-thirds. Key ACLS interventions-including epinephrine administration, airway management, appropriate compression-ventilation ratios, and continuous capnography—were universally implemented, whereas timely defibrillation and the use of antiarrhythmic drugs were less consistent. Team performance demonstrated strong communication, leadership, and post-event debriefing practices, with high-quality documentation recorded in most cases. Return of Spontaneous Circulation (ROSC) was achieved in two-thirds of patients, with nearly half attaining it within 10 min; however, survival beyond hospital admission was limited, with no patients surviving to discharge and only one demonstrating 30-day survival. Neurological outcomes were varied, with a substantial proportion achieving good cerebral performance, though brain death was still observed in some cases. Overall, the findings highlight that while ACLS compliance was strong in several domains, delays in defibrillation and variations in CPR quality remain critical targets for improvement to enhance long-term survival in IHCA.

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